

**PLUS CA CHANGE, PLUS C'EST
LA MEME CHOSE
(The More Things Change, the More
They Stay the Same)
THE DIFFICULTY IN INCREASING
OPERATIONAL MOVEMENT RATES**

A Monograph
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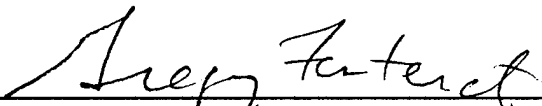
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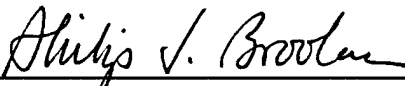
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ABSTRACT

The movement of major combat, combat support, and combat service support units to the decisive place and time on the battlefield is the commander's operational art. Effectively integrating, controlling, and supporting motor, rail, air, and water modes of intratheater transportation is "science". Despite the greater speed of the vehicles, trains, aircraft, and ships involved, statistical comparisons between World War II and Korean War campaigns and recent actions in similar terrain indicate U.S. corps have not improved their ability to conduct operational movements. In desert terrain, Operation DESERT STORM's VII and XVIII Corps did not move to their forward assembly areas any faster than elements of First Army or II Corps did during Operation TORCH. In urban terrain, REFORGER's III Corps did not move faster than its predecessor during the Ardennes offensive. In mountainous terrain, time-distance analysis shows that an armored reinforcing corps could not move from port to sector as rapidly as X Corps did in defending the Line D. Deficiencies in doctrine, equipment, organization, and training inhibit corps from increasing their movement rate.

Current U.S. Army doctrine is not specific or holistic enough to be treated as a science. Doctrine becomes more vague as movements become more complex. Doctrine does not prescribe equipment, organization, and training necessary to support faster movements. Equipment deficiencies complicate movement control, Systematic large-unit training, which peaked with the semi-annual REFORGER exercises in the 1980s, has declined. Computer exercises and the battle command training program in particular, have not compensated for the loss of large-scale field training exercises. Logistics infrastructure shortcomings greatly inhibit the theater army command's onward movement capacity.

Movement rates are only important in relation to an enemy. War plans based on unrealistic movement rate calculations for either friendly or enemy forces are untenable. This monograph recommends solutions to the deficiencies that have kept operational movement rates constant for a generation.

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION.....	1
Modes of Transportation.....	2
II. OPERATIONAL MOVEMENT CASE STUDIES.....	4
Operation TORCH, 1942-1943.....	4
Ardennes Offensive, 1944.....	11
Defense of Line D, 1951.....	12
Operation CERTAIN STRIKE, 1987.....	15
Operation DESERT SHIELD, 1990-1991.....	16
III. REINFORCEMENT OF THE COMBINED FORCES COMMAND, 1996.....	20
IV. DEFICIENCIES IN DOCTRINE, EQUIPMENT, ORGANIZATION, AND TRAINING.....	26
Doctrine.....	26
Equipment.....	33
Organization.....	36
Training.....	38
V. CONCLUSION.....	39
ENDNOTES.....	43

MAPS:	<u>Page</u>
1. First Army's Race for Tunis, 11-17 November 1942.....	49
2. CCB, 1st Armored Division Movement, 18-28 November 1942.....	50
3. The II Corps Operational Movement, 10-25 April 1943.....	51
4. The III Corps Operational Movement, 18-21 December 1944.....	52
5. The X Corps Evacuation Northeastern Korea, December 1950.....	53
6. The X Corps Defense of Line D, 7-22 January 1951.....	54
7. The 1st Armored Division Movement from the ISA to the TAA, 14 December 1990-24 January 1991.....	55
8. Third Army's Operational Movement, 8-22 February 1991.....	56
9. The L Corps Movement from Ports to FAAs, 1996.....	57
10. The L Corps Rail Movement from Ports to CSA, 1996.....	58
APPENDICES:	
A. The L Corps Road March Parameters.....	59
B. The L Corps Road March Tables.....	60
C. Comparative Port Capacity in Southeastern Korea.....	65
D. Comparative Movement Rates.....	66
BIBLIOGRAPHY.....	67

I. INTRODUCTION

A critical aspect of operational warfare is the movement of major combat, combat support, and combat service support units to the decisive place and time on the battlefield. The Army's keystone "how to fight" manual, FM 100-5, Operations, supports this contention:

Tactical actions require timely concentration of units and materiel and often demand short-notice movement of large forces and major shifts in direction of movement.¹

These movements are particularly important because the U.S. Army must reinforce a forward or rapidly-deployed force in theater from the United States. While war planning has addressed strategic deployment and tactical employment in great detail, the planning of onward movement from ports of debarkation to tactical assembly areas is inadequate.

Movement has always played a critical role in warfare. Reflecting on his illustrious career, Napoleon said in 1831, "Marches are war. . . aptitude for war is aptitude for movement."² Clausewitz devoted three chapters of On War to the discussion of marches. He considered marches to be a transition between positions and that armies conducted them under two conditions. The first was to preserve the fighting strength of the soldiers and the second was to ensure their punctual arrival at the desired point on the battlefield. Clausewitz considered a "General principle of modern war" to organize march columns as combined arms forces with unity of command capable of immediate independent action.³ He lamented that despite a reduction in baggage trains, the Prussian army of the nineteenth century could not march any faster than that of Frederick II. Prussia could no longer rely on the mobility advantage that was the source of many Frederickian victories.⁴ Prussian General Helmut von Moltke's quotation applies to operational movement, "An error in initial concentration of armies can hardly be corrected during the whole course of a campaign."⁵

J.F.C. Fuller called movement the "soul of war."⁶ It was a component of his guard, move, and hit trinity.⁷ Like Clausewitz, Fuller felt it essential that marches

preserve the fighting strength of the troops. Similarity of transportation means and speed of movement simplified organizations, logistics, and control.⁸ "In brief, the whole of strategy consists in placing an army, or the various parts of any army, in such positions that tactical movements may be carried out with the greatest economy of force."⁹

U.S. Army doctrine stresses the time-honored importance of movement in war. FM 100-5 defines maneuver as the movement of forces to gain positional advantage over an enemy.¹⁰ Both the Department of Defense and NATO describe maneuver as, "Employment of forces on the battlefield through movement supported by fire, or fire potential, to achieve a position of advantage in respect to the enemy in order to accomplish the mission."¹¹ The commander conducts operational level movement to set the terms of battle by determining where and when to fight or by exploiting a tactical advantage.¹² Effective operational movement preserves freedom of action and protects the force by keeping the enemy off balance.

FM 100-7, The Army in Theater Operations, describes operational movement as the

... disposition of forces to create a decisive impact on the conduct of a campaign or major operations. [It is the] regrouping, deploying, shifting, or moving of service, joint, or combined operational formations to and within the theater from less threatened or less promising areas to move decisive positions."¹³

The commander synchronizes movement with the other five operational operating systems: fires, protection, command and control, intelligence and logistics. Large ground movements require an intensive reconnaissance effort, air and ground defense, service support and traffic control.¹⁴ They are most effective once the joint force achieves air and sea supremacy.

While operational movement capacity has kept pace with the increased size of U.S. Army formations at each echelon, there has not been an increase in movement rate despite greater speed of the vehicles, trains, aircraft, and ships involved. The Army's inability to increase operational movement rates has persisted over time and in all

environments. To illustrate this point, case studies will compare operational moves the Army conducted during World War II and Korea with recent examples in desert and urban (European) terrain. Prospects for increasing movement rates in the near future are not optimistic. A hypothetical movement in Korea, using doctrinal parameters, demonstrates this point will show the difficulty of moving quickly in a restrictive terrain.

Deficiencies in doctrine, equipment, organization, and training inhibit corps from increasing their movement rate. Deficiencies that delay the arrival of a reinforcing corps, might adversely affect the tactical situation. Unrealistic time-distance considerations may make war plans untenable. The only deficiency the Army can correct in the near term is training.

Modes of Transportation

Intratheater transportation makes operational movement possible. The four modes of intratheater transportation are motor, rail, air, and water. Using all modes to maximum capacity minimizes wear on tactical units' organic vehicles.

Motor transport, the primary means of movement support, maintains unit integrity and is least vulnerable to enemy interdiction. Road movement is the most responsive and flexible means of conducting an operational move. Although deceptively simple, road marching is one of the most complex tasks in large unit movement.¹⁵ "Marching is the basic 'skill' on which the art of coordinated maneuver of large units depends."¹⁶ Because large unit movements are impossible to conceal from both rudimentary human intelligence networks and satellites alike, the speed of execution is critical to preventing the enemy from shifting resources and organizing a defense to counter the move.

Rail transportation can move much more tonnage farther than by road. Even though military railroad operating units have steadily declined in number since the end of World War II, rail transportation remains vitally important to operational movements. The military relies on host nation support to provide the tracks, motive power, and rolling stock, although U.S. Army equipment can supplement all three. Soldiers must operate the railroads in the combat zone because the army restricts the use of civilians. If a linear

front develops behind which rail traffic can operate at minimal risk, the controlling agency can use a mix of civilian railroaders and soldiers. When all risk has been eliminated (which usually does not happen until hostilities end) the railroad reverts to civilian operation under military control.¹⁷

Intratheater air transport, the fastest mode of transportation, extends aerial lines of communications. It is either pre-planned or immediate. It is useful for moving priority repair parts, low density/high cost munitions, retrograde of critical repairable equipment or vehicles, and pre-positioning of limited quantities of fuel and ammunition. It is the fastest way of conducting operational moves but is limited in tonnage and relies on a reasonably secure landing zone with material handling equipment (MHE).

Inland waterways can move high tonnage and diversified cargo but at a slower rate than rail. Army water transportation units are normally part of the terminal battalion, and most of their assets have port or lighterage duties. Transport officers rely on host nation operators for inland waterways- although not before those waters are secure. As the case studies will show, effective operational movements depend on commanders optimally using all modes of transportation available in theater.

II. OPERATIONAL MOVEMENT CASE STUDIES

The four succeeding case studies are all examples of operational movements that the U.S. Army considered effective. They occurred in desert, urban, and mountainous terrain. The recent case studies showed that some movement lessons are re-learned by each succeeding generation. The first case study, Operation TORCH, offers an example of how not to conduct an operational move and an example of a proficient move conducted within six months of each other. Despite the half century between TORCH and the last case study, Operation DESERT SHIELD, corps marched at similar rates and encountered similar challenges supporting operational movements.

Operation TORCH, 1942-1943

In December 1941, President Franklin Delano Roosevelt's insistence that American ground forces engage the enemy in Europe in 1942 and British Prime Minister

Winston Churchill's penchant for the indirect approach resurrected plans for a North Africa invasion.¹⁸ Such an operation had several advantages: it would open a second front, providing a degree of relief to the beleaguered Soviets; it would drive Rommel out of Africa and open a line of communication through the Mediterranean; the operation would provide Americans combat experience in a secondary theater of operations; and it exploited the Allies' superior strategic logistics.

The objective of Operation TORCH was seizure of the air and seaport complex between Bizerte and Tunis to sever Axis lines of communication (LOCs). American and British TORCH planners agreed that Axis air power based on Sicily and Sardinia could repel a direct amphibious assault on Tunisia and debated how close they could make a successful landing. Most British planners favored Bone, Algeria, 200 miles from Tunis, while most American planners, fearing Spanish closure of Gibraltar, favored landing on the Atlantic shore of Morocco, 1400 miles away. The compromise called for landings at Algiers, Oran, and Casablanca. From the latter two positions, forces could seize Spanish Morocco if Spain joined the Axis, while forces from Algiers could move directly toward Tunisia.¹⁹

The movement of the three-corps invasion force across northwest Africa quickly enough to reach Tunisia before the Axis could counter the move required active French assistance, not mere neutrality.²⁰ The Allies needed the French to provide transportation assets, secure the long LOCs, and resist the Axis seizure of Tunisia. The Allies needed all available French railroad locomotives, rolling stock, and operators as well as trucks and drivers. The availability of French warships, transports, fighters, and transport planes would have simplified the operation by augmenting allied assets, but planners did not rely on them. Unfortunately, Vichy Armed Forces Commander Admiral Jean Francois Darlan's five-day vacillation concerning support for the Allies gave the Germans a significant advantage in the operational movement race for Tunisia.²¹

The campaigns in Northwest Africa become a race to determine which side could concentrate forces in Tunisia first.²² On 9 November 1942, a day after the TORCH landings, a German division made its operational move by air to seize Bizerte and by

ferry to secure Tunis. From Sicily, German forces were only ten minutes by air and 17 hours by ferry from Tunisia.

British experience in the Western Desert since the outbreak of the war taught the interdependence of land, sea, and air forces in controlling the narrow coastal strip. Armies depended on resupply by sea. Air strips were key to air forces' efforts to provide air cover for the ships. Both the tonnage of supply and land transportation requirements increased as armies gained ground. Armies that overextended their resupply capability culminated. The defender who withdrew and compressed his own supply lines, could accumulate the logistical strength to support a counteroffensive. The combatants repeated this pattern five times.

Between 11 and 17 November 1942, the Allied First Army, TORCH's Eastern Task Force, used road, rail, air (both air land and air drop), and sea to push its screening forces to Medjez el Bab and Gafsa. The Allies "piecemealed" their effort for the sake of speed. The First Army initially moved an infantry brigade group, an armored task force, three airborne battalions, a commando battalion and portions of a division CS and CSS structure, approximately 12,000 soldiers, 625 kilometers in six days (see Map 1). This was a 4.3 kilometer-per-hour (kph) movement rate.²³

Because the enemy was rapidly strengthening its position in Tunisia while the French and Spanish threat diminished, Eisenhower decided to reinforce Eastern Task Force with 1st (U.S.) Armored Division's Combat Command B (CCB) from Central Task Force. He also decided that CCB would reinforce the screening force immediately despite Eastern Task Force's strained logistics and the requirement for an 1120 kilometer move from Oran to Tunisia.²⁴

The CCB Commander, Brigadier General Oliver, used all means available to conduct his operational move. Between 18 and 28 November, three tank battalions moved from staging areas near the port of Oran and assembly areas in eastern Tunisia (see Map 2). The 1st Battalion, 13th Armor (1/13 Armor) moved its tanks by rail from Oran to Tunisia but had to march its half-tracks with its trucks overland. The 2nd Battalion, 13th Armor drove 400 kilometers to Algiers, embarked and sailed to Bone,

then drove the remaining 208 kilometers to its assembly area. The 1st Battalion, 1st Armor managed to move all except its trucks by rail road marching the final 128 kilometers to its positions. The tanks went directly into combat with each of three allied brigade-sized task forces on 25 November 1942.²⁵

The CCB selected a route south of the Atlas Mountains for its wheeled road march. The CS and CSS units began their march on 22 November as planned while the remaining combat units awaited trains. When it became clear the Algerian railway could not support CCB fast enough, General Eisenhower gave Brigadier General Oliver permission to road march 1st and 2nd Battalions, 6th Infantry, 27th Field Artillery Battalion, 1st 13 Armor's half-tracks and CCB headquarters on a trans-Atlas route. With canvas rolled back to avoid surprise air attack, the brigade-sized convoy departed 24 November in the rain and sleet.²⁶

The Allies did not centrally control the 1120 kilometer convoy route. CCB lacked the jeeps and motorcycles to control traffic effectively. The kitchen trucks and wreckers with the other wheels departed two days before the last convoy. A snowstorm at Sloughia delayed the wheel convoy causing the half-tracks to catch-up with its rear. Luftwaffe air attacks caused several delays as the convoys moved through western Tunisia. Despite these movement control difficulties, CCB arrived in forward assembly areas on 28 November with very few stragglers, having moved approximately 442 armored and 403 wheeled vehicles at a 4.7 kph march rate.²⁷

The Allies arrived a Tunisia with too little, too late, reaching within 15 miles of Tunis before being pushed back to Medjez el Bab again on New Year's Day. Although First Army moved 30,000 soldiers, 628 tracked vehicles, 1355 wheeled vehicles into Tunisia in 17 days, the Germans won the race to concentrate forces.²⁸ The winter rains made mounted combat and air operations impossible until March 1943. Had TORCH campaign planners added CCB and appropriate CSS assets to Eastern Task Force from the outset, or had Eisenhower decided to shift CCB east earlier as a unit, the Allies might have had enough combat power to take Tunis and Bizerte in 1942. The Allies learned important lessons about operational movement.

TORCH planners learned that existing logistics, all modes of transportation, and movement control were inadequate for moving allied forces from port to the battlefields. General Eisenhower risked sending combat forces ahead of CSS units in a bid to seize Tunisia quickly. The gambit failed. At least the winter rains gave him time to correct logistical problems and build overwhelming combat power for the spring offensive. By the time the remainder of II Corps arrived at Oran from Northern Ireland in December, the Allies had just begun developing the movement infrastructure in North Africa.

The logistics challenge began at the ports. The Allies wrestled with what doctrine now calls Total Asset Visibility (TAV) and In-Transit Visibility (ITV). Stevedores off-loaded ships so quickly that they often piled supplies on the dock without inventory control. Some shippers poorly packed or failed to mark material. Port personnel lacked the training and discipline to record the mountains of supplies being handled. Weather damaged some supplies that lacked warehousing. The Allies lost control of their supplies at port, lacked a system to track them en route, and had no idea what units actually received. Although resolved somewhat by training, discipline, and experience as time passed, resupply inefficiencies plagued the Allies throughout the Tunisian campaign.²⁹

The motor mode of transportation suffered from a shortage of trucks, drivers, and good roads. To fill the shortage of vehicles and drivers, the Allies contracted for 350 coal-fired trucks and many more civilian drivers.³⁰ The lack of adequate roads was more serious. Only by an extraordinary effort did the Corps of Engineers maintain theater MSRs. Treacherous curves and steep grades in the mountains and washouts on the valley floors plagued convoys despite the engineers best efforts.

Eisenhower's staff anticipated the problems with road movement. It therefore placed importance on rail transport. The staff calculated the theater would eventually require 250 locomotives and 4500 rail cars of both standard (1435 millimeter) and narrow gauges (1 meter) to move units and supplies to Tunisia. Although the invasion did surprisingly little damage to the 1410 mile rail line connecting Casablanca with Tunis, the Allies found the locomotives, rolling stock, and rails to be in poor repair. Even so, 12 daily trains managed to carry 5760 tons of material.³¹

Following the January Casablanca Conference, General Somervell convinced General Eisenhower that lack of motor and rail transport was the largest logistics problem in theater. Consequently, Eisenhower ordered a special convoy from America. Convoy UGS-5 1/2 delivered 4000 service troops, 4536 2 1/2 ton trucks 18 one-ton trailers, 5 locomotives and 50 narrow gauge railway cars.³² Eisenhower later commented that the success of the North African campaign was due largely to the contents of the special convoy.³³

By the spring of 1943, a railway shop battalion had assembled 38 locomotives and 233 cars in at Oran. With the UGS-5 1/2 equipment and the arrival of a Railway Grand Division, the railroad moved 7600 short tons per day.³⁴ Rails carried approximately equal tonnage as roads thereafter.

The lack of centralized movement control in 1942 hampered both operational moves and routine resupply convoys. Operators could not centrally control movements until they solved problems caused by intermittent civilian telephone systems, scarcity of road signs, shortage of soldiers for traffic control points, inadequate movement control training, and march "indiscipline". Americans learned from their experienced, British partners. By winter's end the Allies held nightly meetings at 2100 hours to establish theater movement priorities for all modes of transportation.³⁵

The Allies' solution was to schedule and conduct road movements like a railroad block system. Movement control headquarters placed dispatchers at traffic control stations located 48 kilometers apart. They linked these stations with military telephone lines. The theater standard operating procedure posted the march speed at 40 kph (outside town) with vehicles 100 meters apart. Advanced parties would race ahead to each subsequent traffic control station to report and coordinate while the convoy closed. Lead vehicles displayed blue flags while trail vehicles flew a green flag (a practice that continues today). Each convoy carried seven days' rations and 800 kilometers of fuel, reducing the number of resupply points. Guards accompanied the convoys to secure them at halts, but there were never enough drivers to provide two per vehicle. Convoys were never able to operate continuously. Local French or Arab guides helped allied

drivers navigate in port, staging areas, and along routes leading the MSRs. The guide requirement diminished as driver experience rose.³⁶

Air and water transport did not significantly reduce the burden on ground movement. Air transport was available for specific airborne missions but was not routinely available for intratheater lift. Until the summer of 1943, the Luftwaffe contested the air space, making air transport a hazardous proposition. Planners sometimes used coastal shipping to bypass congested roads and rail lines in theater, but the radius of land-based air cover limited the shipping range. Landing Ship Tanks and other amphibious ships were in such short supply that movement planners considered water more a mode of opportunity.

The final phase of the Tunisian campaign provides an example of how proficient the American troops had become at operational movement since their arrival. Under Lieutenant General Patton's leadership, the II Corps erased the Kasserine Pass defeat and linked-up with the British Eighth Army on 7 April. Eighteenth Army Group had planned to pinch out the II Corps zone after Eighth Army reached Kariouan. General Eisenhower intervened to ensure the II Corps, and its new commanding officer, Lieutenant General Omar Bradley, received a zone of action until the Allies reached their final objectives. Consequently, the II Corps had to move from the southern flank to the northern flank across the army group's line of communication (see Map 3).

The II Corps, with the assistance of 126 HETs and 230 2 1/2 ton trucks with trailers, moved its divisions north in the sequence of planned commitment under First Army centralized control. The 9th Infantry Division moved first and farthest from El Guettar to Sedienane, 10-13 April (432 kilometers in 72 hours, or a 6 kilometers-in-an-hour march rate). The 1st Infantry Division followed from 14-17 April. The 1st Armored Division moved 19-22 April with 34th Infantry Division trailing by a shorter route (320 kilometers) closing 25 April 1943. Some 40 II Corps units merged into the routes. The II Corps moved approximately 90,000 soldiers, 1955 armored vehicles, 9724 trucks, and 1,100 tons of stockpiled ammunition 432 kilometers in 15 days. They moved over mountain roads, in driving rain, and harassed by enemy aircraft. Despite initial

confusion, the movement ended in orderly fashion and in time for the 18th Army Group's decisive attack to seize Bizerte and Tunis on 22 April 1943.³⁷

Ardennes Offensive, 1944

In contrast to the immature transportation infrastructure of North Africa, the European theater of 1944 had a well developed road, railroad, airfield, and waterway network. The most publicized operational movement the U.S. Army conducted in Europe during World War II was the III Corps counterattack of 19 to 21 December 1944. The attack into the southern flank of the German held "Bulge" to relieve the beleaguered 101st Airborne Division and restore the front was successful application of operational maneuver. III Corps rapidly moved its organic and supporting units, made a transition to an effective assault, and penetrated a veteran German corps.

The 16 December 1944 German Ardennes offensive achieved tactical and operational surprise. The German's early success had an immediate impact on Third Army. The 12th Army Group Commander, General Bradley, ordered Patton to release 10th Armored Division to General Hodge's VIII Corps which was trying to hold the southern shoulder of the German penetration. Although Patton continued to plan and prepare for Third Army's breach of the Westwall fortifications (scheduled to be led by XII Corps on 19 December), he warned Lieutenant General Millikin, the III Corps commander, to be prepared to attack north if the situation in the Ardennes deteriorated. Patton ordered his staff to plan for this contingency and had already established the four routes for his counterattack. On 17 December, Third Army ordered two military police battalions to reconnoiter the routes and prepare for traffic control responsibilities.³⁸

By the next morning, 18 December, the situation was grave enough for General Bradley to ask Patton what Third Army could do to assist. Patton informed Bradley that he could respond with a corps. Patton canceled the eastward attack and began planning a northward attack instead. Third Army staffing planning increased in intensity. It proposed a boundary shift, planned three counterattack courses of action, shifted logistics support for both III Corps attack and the relief of VIII Corps, and ordered XX Corps to assume III Corps sector.³⁹

The III Corps was equally active. Corps headquarters displaced to Longwy to better control the movement. The 4th Armored Division began its move at midnight, 18 December, on Routes A and B (see Map 4) under blackout conditions. The division closed 26 1/2 hours later in their FAA. The division moved 2,500 vehicles (957 tracks and 1574 wheels) 181 kilometers for a march rate of 6.8 kph. The 80th Infantry Division moved 2265 vehicles (161 tracks and 2106 wheels) on routes C and D in daylight. It covered 120 kilometers (exact time is not available) from 19-20 December. On 20 December, 27th Infantry Division followed 80th Infantry Division on routes C and D. It moved its 2265 vehicles 80 kilometers closing at 2310 hours on the same day. Corps artillery units from all three Third Army corps moved from their various positions to a concentrate northwest of Longwy from 19-20 December. A total of 870 wheels and 252 tracks moved, integrated into the three divisions.⁴⁰

Although the move was not perfect, it was effective. Weakened bridges, enemy air attacks, winter weather conditions, and traffic accidents conspired to slow the movement. From 19 to 21 December 1944, III Corps moved approximately 80,000 soldiers, 1713 armored vehicles, and 7691 trucks 181 kilometers at a rate of 3 kph.

Defense of Line D, 1951

In November 1950, the Red Chinese Army attacked an over-extended X Corps in eastern North Korea. The X Corps' 1st Marine Division, 7th (U.S.) Infantry Division, and I (ROK) Corps, were defeated piecemeal and forced to retreat. The Chinese concentrated their attack on the Americans split by the Changjin (Chosen) Reservoir. The Chinese blocked the UN line of withdrawal, forcing 1st Marine Division and the survivors of the Army's Task Force Faith to break out of Hagaru-ri and hasten southward.

The success of the Chinese counteroffensive convinced General MacArthur to consolidate his defense. He ordered X Corps to withdraw and evacuate via Hungnam, Wonsan, and Yon'po to Pusan and then move north to anchor the UN line from Wonju to the Taebaek mountains. From 8 December 1950, when X Corps received withdrawal orders, until 27 December, when it had to be in position along defensive Line D, the staff had to plan a breakout from encirclement, a withdrawal under pressure, an operational

movement by motor, rail, air, and sea, and a defense. To plan each of these operations in detail, the staff formed three planning sections: one to plan the withdrawal, another the evacuation, and a third to plan the debarkation, movement and defense along Line D.⁴¹ For execution of this order, the X Corps concentrated all air support assets against the Chinese encircling the Marines, committed 3rd Infantry Division to defend a perimeter around Wonsan and Hungnam, secure Yon'po airfield, and support the withdrawal of all X Corps soldiers and equipment (see Map 5).⁴²

The X Corps used all transportation modes to accomplish the evacuation of North Korea. Movement planners maximized load capacity of trucks, trains, planes and ships to reduce the turn around requirement. The equipment-dependent Allies were confined primarily to the roads. ROK divisions road marched 366 kilometers from Ch'ongjin and 295 kilometers from Hapsu to reach the port perimeter near Hamhung. Most of 7th Infantry Division road marched 240 kilometers from the Yalu river line to reach their port staging area. The U.S. Marines' retrograde from Hagaru to Hungnam was the shortest, 110 kilometers, but the most contested. Once the Marines reached Chinhungni, they loaded large numbers of men and vehicles on trains for the final move to port.

Airlift and sealift were critical to the success of the evacuation. Air and sea superiority were necessary for this evacuation to proceed smoothly. Transport and liaison aircraft and helicopters evacuated 4300 wounded soldiers and many tons of critical supplies from Hagaru-ri to Yon'po. From 10 to 15 December, subsequent airlift evacuated 3000 soldiers, 50 tons of bombs, 200 vehicles, and a number of refugees from Yon'po to various airfields in South Korea.⁴³ From 10 to 24 December, sealift evacuated 105,000 soldiers, 350,000 tons of supplies, 17,500 vehicles, and 98,100 refugees.⁴⁴ The I ROK Corps redeployed to Samchok by 20 December to anchor the UN defensive line B on the sea. Most other X Corps units were shipped to Pusan with some going to Pohang. Lieutenant General Almond, the X Corps Commander, risked loading ammunition directly from the dock as opposed to deep in harbor by lighterage.⁴⁵

On 28 December, General Ridgway pressed LTG Almond to expedite his reorganization around Pusan and move into defensive positions along Line D. Before the

northward movement began, Communist forces turned the UN right flank. Eighth Army ordered the X Corps to destroy the enemy penetration and protect the IX Corps east flank.⁴⁶ The next day, the X Corps began movement by sending 7th Infantry Division to Chech'on, where routes 60 and 29 intersected. On 3 January, the X Corps assumed a 35-mile sector of Line D with route 29 as its single main supply route (see Map 6). The Corps accomplished in three days what it had anticipated taking 8-10 days.⁴⁷

Divisions converged on the X Corps position from many directions due to task organization changes. By 2 January 1951, the X Corps received the 2nd (U.S.), 2nd (ROK), 5th (ROK), and 8th (ROK) Infantry Divisions, and detached 3rd (U.S.) Infantry and 1st Marine Divisions. The 7th Infantry Division and X Corps CS and CSS units made the longest move: from Pusan to sector. North Korean guerrillas operating in the Taebaek mountains frequently interdicted route 29. Forward progress was also slowed by steep grades, sharp turns, winter weather, and poor road maintenance.⁴⁸ Despite adversity, the 7th Infantry Division moved approximately 10,000 soldiers and 2,358 vehicles 344 kilometers in three days for a rate of 4.8 kph.

The situation at Pusan hampered X Corps' efforts to deploy rapidly northward. A lack of skilled stevedores and transportation assets to move supplies from port dumps reduced Pusan's port capacity from a potential of 45,000 tons per day to only 14,000 tons. Vessels waited up to 25 days to discharge cargo. Although the embarkation at Hungnam was fast, debarkation at Pusan was slow. X Corps supply ships were intermingled with those carrying Eighth Army goods.

Railroads were key to moving what had been unloaded. Much of X Corps' supplies moved by rail from Pusan north 160 kilometers, and then by truck to various dumps. The small (20-40 car) trains could only carry 500 tons freight. The 25 supply trains a day would move only 12,500 of the 14,000 tons unloaded each day. The remainder moved by truck.⁴⁹ Planners worried that after the loss of Inchon a second time, UN forces were too dependent on Pusan. The UN concentrated its logistics dumps, transportation and MHE assets in a small area, making Pusan a lucrative guerrilla target as well as a Communist objective.

Operation CERTAIN STRIKE, 1987

Forty-three years after the Battle of the Bulge, III Corps returned to the European theater to conduct another counterattack. The Return of Forces to Germany (REFORGER) exercise CERTAIN STRIKE 1987 was the largest overseas deployment of U.S. Army forces ever conducted in peacetime.⁵⁰ It was also the only corps-sized deployment executed during the REFORGER program. NATO's Northern Army Group (NORTHAG) tasked III Corps to deploy from Fort Hood, Texas, draw equipment from its POMCUS (pre-positioning of material configured to unit sets) sites, and attack the flank of an enemy penetration of the NORTHAG sector. The III Corps deployed the 1st Cavalry Division, augmented by a brigade from the 4th Infantry Division, the 2nd Armored Division, the 45th Separate Infantry Brigade, the 6th Cavalry Brigade (Air Combat), the III Corps Artillery and Corps Combat Support Brigade, and the 13th Corps Support Command. A total of 11,000 vehicles were either drawn from POMCUS sites or off-loaded from ships.

The III Corps prepared for combat in staging areas near Muenster and Osnabruck. Conducting the counterattack required III Corps to move across the rear of the forward defending corps. NORTHAG's Joint Movement Coordination Center (JMCC) delegated movement control to III Corps. The JMCC required III Corps to submit its march tables for approval. The JMCC provided three routes per division from staging area to line of departure, and four routes for the Corps thereafter.

The III Corps developed and published a movement SOP to standardize how corps units at each echelon road marched. The corps validated its march data and enforced discipline on a training road march from Fort Hood to San Angelo, Texas. From this march data, the staff developed the Corps Automated Movement Planning System (CAMPS) to plan march tables. The CAMPS data base enabled planners to Generalerate march data quickly.⁵¹ For REFORGER, planners fed this data into the HEROS-5 computer to ensure that the operational movement conformed to German peacetime traffic restrictions. German traffic authorities allowed the III Corps to use all four lanes for single-direction traffic for a specific portion of the autobahn. This

technique reduced column lengths and TAA closure time (interestingly, march speeds, vehicle intervals, and march unit sizes mirrored those of Third Army SOP in 1944).⁵²

The III Corps opted to move its command and control, signal, and intelligence units first. Based on rehearsals, corps added air defense units to its list of march units preceding the corps main body. It provided a corps refuel on the move (ROM) site and its own TCPs. Units within the corps and division support areas remained stationary until the combat brigades cleared the TAAs.

Several factors contributed to III Corps' successful movement in 1987. The corps planned, rehearsed, and standardized its movement procedures prior to deployment. The JMCC coordinated the movement accommodated last minute boundary changes. Computerized route planning helped planners develop realistic march tables. Helicopters helped the provost marshal and operators control the movement.

The III Corps moved 150 kilometers in 36 hours at a 4 kph march rate. Although corps planners claimed that the corps could have moved faster without German highway safety restrictions, it did not face the adverse weather, enemy interdiction efforts, and displaced civilian interference that will likely retard march rates in war. The III Corps movement was competently executed and the counterattack ultimately successful, but they executed it no faster than their World War II counterparts.

Operation DESERT SHIELD, 1990-1991

Forty-nine years after Operation TORCH, the United States Army again had to make operational movements in a desert environment. Many of the conditions and planning considerations were similar. Saudi Arabia, like North Africa, had few hard-surfaced roads and only one railroad connecting the ports with inland cities. The host nation capacity to support movement early in each deployment was proportional to the number of vehicles and tonnage of supplies requiring movement. Port capacity exceeded ground or air capacity for onward movement. Logisticians lost visibility on supplies stockpiled near the ports. The lack of heavy equipment transporters (HETs) and MHE early in each deployment exacerbated the port backlog. An acute tire shortage further

limited HET transportation. A driver shortage prevented 24-hour convoy operations. Finally, the Allies had to relearn how to centrally control movements.

SHIELD movement planners had three notable advantages over their TORCH predecessors. First, the Allies enjoyed air supremacy in Saudi skies.⁵³ Control of the air enabled Allies to move day and night at close vehicle interval. The second advantage was that of being on the defensive. This enabled General Schwarzkopf to husband his combat power until he built an overwhelming counterattack force. The third advantage was the monetary wealth of the Gulf Cooperative Council nations. They could afford to buy whatever they lacked to support the Allies. This allowed logisticians to make "on-the-spot" contracts to buy goods and services that the Allies needed.

Units packed much of their supplies in military and civilian-contracted containers for ease of handling and movement. While "containerization" increased the speed of transferring supplies between modes of transportation and reduced the stevedore requirement, it did not prevent Central Command (CENTCOM) from losing control of containers and their contents. Although the army used a bar code system, often the quickest way for units to claim their containers was to cruise through the container lots either at the intermediate staging area (ISA) or at the logistics base in the desert and look for their unit number painted on the side. Innumerable containers failed to reach their units, forcing units to reorder parts and equipment that suppliers had been shipped. This generated duplicate and even triplicate shipments of certain critical items. Not only was in-transit visibility (ITV) of containerized supplies lost during Desert Storm, but packaging within the container was not standardized, making it hard to find specific contents.

To build sufficient combat power to defend Saudi Arabia, General Schwarzkopf gave combat units priority over CSS units during the initial deployments. This decision continued to hinder the deployment of follow-on forces. "Operational art is conducted in the offensive by trucks HETs, lowboys. . . other line-haul vehicles, and cargo and fuel carriers that are able to accompany fighting vehicles into an enemy's operational depths (300-400 kilometers)."⁵⁴ As late as 14 January 1991, Major General Arnold, ARCENT

G-3, lamented that MHE, HETs, lowboys, and stake and platform trucks were still well short of the requirement.⁵⁵ Lieutenant General Yeosock, Third Army Commander, took several steps to fix the problem. He personally participated in the "great HET hunt". He enlisted the support of the U.S. Army Vice Chief of Staff, General Sullivan, and the 22nd SUPCOM commander, Lieutenant General Pagonis, to deliver the 1295 HETs required to complete the onward movement of Third Army. The number rose from 461 in theater in 14 January to 1404 at the conclusion of Desert Storm. The final tally included all the HETs in the U.S. Army inventory, U.S. commercial vehicles, and military and commercial HETs from Saudi Arabia, Egypt, Italy, Czechoslovakia, East Germany, and Poland. On 7 December 1990, HETs were the number one priority on ARCENT's situation report.⁵⁶ The irony remains that despite ARCENT's gargantuan effort, the Iraqis still had more HETs than the Allies at war's end.

Overloaded HETs wore out tires at an alarming rate. Heavy duty truck tires are a scarce commodity worldwide. LTG Yeosock personally intervened to solve the HET tire problem as well. On 16 January, 3000 HET tires were one of ARCENT's highest priority requisitions.⁵⁷

On 22 December 1990, 10th Personnel Command drafted 7444 drivers from the Reserve Component and from the 3rd Battalion, 2nd Air Defense Artillery into a driver pool.⁵⁸ These soldiers drove buses, every type of U.S. Army truck, and commercial line-haul trucks. Despite the driver recruitment effort, there were never enough drivers to provide continuous convoy operations.

Third Army refined centralized movement control during the seven months prior to G-day. The 318th Transportation Agency (Movement Control), from New York City, scheduled moves on ARCENT's main supply routes (MSRs). The 318th established Final Destination Reporting Points (FDRPs) with translators to give final directions in several languages to convoys (or lost strays). Highway Regulating Point Teams (HRPTs) recorded and reported each convoy as it passed and helped vector MP patrols to errant convoys. The 318th created a Theater Movement Control Center (TMCC) with cellular phones, hand held radios, FM radios, high frequency AM radios, and electronic mail.

Corps sent representatives to the TMCC to assist in controlling their unit's movements. Traffic was plotted on an enormous wall map.⁵⁹ Despite some innovations and technological improvements, this system for centralized movement control was the same as the one the Allies developed in North Africa.

In Operation DESERT SHIELD, 1st Armored Division was VII Corps' first division to move from the intermediate staging area (ISA) to tactical assembly area (TAA) (see Map 7). The division moved 1819 tracked vehicles, 6231 wheels, 124 helicopters, 966 containers, and 17,428 soldiers (22,234 including attachments) 410 kilometers in 34 days.⁶⁰ About 240 HETs moved all the division's tracked vehicles, with the exception of two Bradley battalions that roadmarched because of the HET shortage. A fleet of 350 buses moved the track crewmen while their tracks moved by HET.⁶¹ Helicopters and wheels self-deployed. Many of the containers moved by rail from port to Riyadh, where overhead cranes placed them on flatbed trucks for the final leg of the 845 kilometer journey to the TAA. The 1st Armored Division moved three times as much material as 1st Army did in the 1942 bid to seize Tunisia, but required four times as long to complete the move.

The crowning achievement of operational movement during DESERT SHIELD was the movement of two corps from TAAs to forward assembly areas (FAAs) on routes that crossed twice (see Map 8). In 14 days, XVIII Airborne Corps moved 115,000 soldiers, 4,366 tracked vehicles, and 21,000 trucks an average of 580 kilometers to position itself on the western flank of Third Army. At the same time, VII Corps moved 140,000 soldiers, 6,596 tracked vehicles, and 32,000 trucks an average of 226 kilometers to position itself for the decisive operational maneuver between the XVIII and the Arab Corps. TMCC assigned block times which synchronized the two corps' movements. Despite the potential for the greatest military traffic jam in history, the movement proceeded remarkably smoothly.

The case studies show movement rates in desert and urban terrain has not increased since World War II. A hypothetical future deployment to Korea illustrates that operational movement rates in restrictive terrain have not improved since the Korean War. Several factors conspire to hinder such a move: shortage of time; deficiencies in Korean transportation infrastructure; lack of HETs, MHE, and portable ramps in the U.S. Army inventory; and, the current size of U.S. corps. It is the last factor that exacerbates all the other limitations.

III. REINFORCEMENT OF THE COMBINED FORCES COMMAND, 1996

The scenario that generates the requirement for the operational move is not unfamiliar. Rising tensions cause the Combined Forces Command (CFC) commander to place his units to defensive positions. Degenerating political relations between north and south Korea prompt the CFC commander to request reinforcement. In accordance with the war plan, the U.S. Army Chief of Staff alerts the L Corps, but directs it to deploy only units immediately ready for combat (C-1). Only one heavy division reports being entirely combat-ready. A second heavy division reports two C-1 brigades. A third heavy division has one C-1 brigade. A fourth division has only individual battalions to deploy. No affiliated national guard unit is able to respond in time. By task organizing, L Corps can deploy two full-strength divisions: one mechanized infantry and one armored. In addition, L Corps will take an armored cavalry regiment, a two-attack-battalion aviation brigade, two three-battalion artillery brigades, and a full complement of Corps CS and CSS assets. The L Corps plans to move 4100 tracked vehicles, 14,300 wheeled vehicles, and 100,000 soldiers to the Korean peninsula (see Appendix A).

The CFC commander's first consideration concerning the reinforcing corps' movement is time. With about 70 percent of its ground maneuver forces within 100 kilometers of the DMZ, north Korea can attack on very short notice. If north Korea learned anything from its failed 1950 invasion (or from watching the Iraqi debacle on television), it is that they must make a determined effort to block the arrival of U.S. reinforcements. Missile, air, naval and special operations forces are all means to this

end. The danger of imminent attack suggests to the CFC commander that the movement be tactical rather than administrative.

The CFC commander orders his Ground Component Command (GCC) commander to move the L Corps from the ports of southeast Korea to a defensive sector from the Han River across from Yaju to the Taebaek mountains' spine. This sector centers on Wonju, where principal north-south and east-west routes intersect. This was the X corps' sector 45 years previously. Because the distance from the ports to the Wonju sector is between 339 and 440 kilometers (depending on the route, see Map 9), road marching would cause significant wear and tear on tracked vehicles. The commander considers how to limit the wear on his tracked vehicles without compromising the corps' ability to transition rapidly to combat operations.

The CFC commander tells the GCC commander to use as many routes as possible to move the corps and to do so without blocking the resupply of other units already in sector. Considering this guidance, the GCC commander directs his staff to plan L Corps' move so that it is fast, secure, conducive to unit integrity, and does not gridlock Korea's restrictive transportation net. The J-2 shares enemy situation, terrain, and weather intelligence with the L Corps G2. The J3 discusses time/distance factors, reporting requirements, and movement control information with L Corps G3. The J4 explains what logistical support he will contribute to the move and that support L Corps will provide for itself. The GCC commander accepts risk in moving some tracked vehicles by HET and rail to save wear on vehicles and roads. Because the movement origin, route, and destination are all within the GCC area of operation, the GCC commander will command the movement. Even though the J3 will control the move, the Theater Army Movement Control Agency (TAMCA) will assist by allocating space and time on the approved routes.

To alleviate the port backlog and to avoid presenting the enemy a lucrative sabotage or deep strike target, the CFC plans to use five southeastern ports: Masan, Chinhae, Pusan, Ulsan and Pohang (see Appendix C). In a 1991 study of Korean infrastructure, the Army's Concepts Analysis Agency concluded that due to limited

numbers of stevedores and container handling equipment at the ports, and highway and railroad carrying capacity, the Army would experience a two to five week delay in clearing staging areas.⁶² Although south Korean ports have sufficient berthing to accommodate reinforcing corps and resupply shipping, the ports have limited intermodal capability. These ports have insufficient container handling equipment to transfer the U.S. Army's largely containerized supplies to railroad flatcars or flatbed truck trailers. The rail cars and trailers are in short supply as well. The ports suffer from a shortage of stevedores to off load both break-bulk and roll on/roll off ships.

Eighth Army controls the aerial and sea ports of debarkation, reception and staging. Once airlifted soldiers link up with their vehicles, control passes to the GCC commander. The TAMCA uses the movement data program developed for an armored corps in mid-1995. Movement planners realize that allowing the corps to control its own move in a theater where all CFC units rely on shared use of a few key MSRs, rail lines, airports, and seaports, invites failure.

There are few road and rail connections between the southeastern ports and the Wonju sector in central south Korea. The Koreans built their ground transportation network to support Seoul to Pusan and Seoul to Kwangju commerce. In these corridors, the primary networks are dual-lane expressways and an electrified double rail line. In April 1994, the south Korean government announced its plan to spend \$77.5 million to improve ports, transfer terminals, highways, and railroads to speed the domestic cargo distribution flow more evenly throughout the country. While this development plan includes inland container depots, cargo terminal complexes, airports, port container facilities and rail lines.⁶³ This development plan may alleviate some of the transportation problems in the next decade, but it will not solve CFC's current rapid reinforcement dilemma.

The principal highways and rail lines that serve all five ports converge in a nexus north of Pusan. This congested area, like the Pusan itself, represents a high value target to the enemy even if ships off load in dispersed ports. This nexus also represents a traffic bottleneck that will complicate movement planning.

There are two limitations on road movement: lack of an adequate road network that can support an armored corps, and the lack of HETs in the U.S. Army inventory. In 1951, the only hard surface roads on the entire Korean peninsula were within a 30 kilometer radius of Seoul. All other roads were either graded loose surface or dirt. Principal arteries were all-weather and regularly maintained. Although the condition of the roads in the south has improved considerably since 1951 (most are paved and have bridges), the number of new routes in the region has only increased 10 percent. Only heavy-duty two-lane roads or divided highways can sustain prolonged corps traffic without damage. In the southeast quarter of Korea, there are only five distinct routes that can support a corps move. A corps movement inadequately supported by an extensive engineer effort will destroy secondary paved roads. The Wonju sector in particular would require a continuous, arduous engineer effort to ensure the movement into sector did not destroy the roads limiting future combat, CS or CSS operations.

The second limitation to road movement is the number of HETs available to the reinforcing corps. The U.S. Army possesses the same 476 HETs as it did during DESERT STORM. The active component has only two battalions. Without activating the reserve component, a host nation support agreement, and a pre-arranged contract for commercial HETs, there will not be enough HETs at the outset of a crisis. Those HETs the Army does have cannot operate continuously because the force structure assigns only one driver per vehicle.

The railroad passing sidings are short -- restricting the length of trains on single-track lines to 15 cars and on the dual-track main line to 22 cars. This slows train turnaround time and limits rail carrying capacity in remote sectors (such as the area south and east of Wonju.). The lack of MHE for containers and portable ramps for vehicles reduces the efficient use of rail in all but the terminal cities. It limits the railroad's capability to compensate for the sparse highway network in places where CFC forces will fight.

Moving some of the tracked vehicles by a combination of rail and HET reduces consumption of fuel and repair parts and damage to the roads. Division commanders

could integrate HET convoys into their march columns. CSS units could transport by train all of the supplies and equipment that they cannot move in a single truck convoy. This equates to 50 percent of the Corps Support Command (COSCOM) and the Division Support Command (DISCOM).⁶⁴ Airlifting command posts, liaison teams, air defense units, intelligence units, quartering parties for ROM sites, and TCPs would allow these specialized units more time to accomplish their missions and eliminate a degree of road traffic. This confines the remainder of the corps to the roads.

Because the terrain limits the highway and rail net, Koreans rely on air transport to reach remote areas for both military and commercial purposes. Consequently, Korea has numerous hard surface airfields throughout the country. Additionally, there are several stretches of highway where planes can land. For example, there are five major and one minor airfield within supporting distance of the Wonju sector. Wonju itself has an airfield with a 6000 foot runway and a minor airstrip suitable for helicopter operations. Airfields at Ch'ongju, Yech'on, and Yongju have 6000 foot runways. These cities are two thirds of the distance from ports to sector. Chech'on has a 3000 foot runway with adjacent storage structures conveniently located near a major railroad classification yard ideally suited for a corps support area. With all these airfields, intratheater airlift could reduce ground traffic congestion somewhat.

Although south Korea has modernized its transportation infrastructure since 1950, its capacity has not grown in proportion to the increase in a U.S. Army Corps's size and weight. The divisions and their habitual attachments, a corps' primary component, have increased in size two and a half times since the Korean War.⁶⁵ There are seven times more tracked vehicles. The average weight of these vehicles has doubled. To avoid traffic gridlock, planners must use the maximum carrying capacity of each transportation mode. Using all modes most efficiently conflicts with configuring for tactical movement.

The L Corps Commander decides to move combat brigades with supporting artillery, engineer, and forward support battalions from both divisions simultaneously rather than moving divisions sequentially. This maximizes the command and control

infrastructure in sector from the outset of the move. He also decides to have the divisions help support their own moves over their own routes. These routes will become their MSRs once the Corps is in position. The 23rd Armored Division is to use the ports of Masan and Chinhae, move to staging area A, move over routes RED and GREEN, and occupy its sector near Yaju (see Map 9). The 52nd Infantry Division (Mechanized) debarks at Pohang and Ulsan, moves to staging area B, moves on routes BLUE and GOLD, and occupies its sector near Wonju. The remaining Corps troops arrive at Pusan, move to staging area C, move containers and bulk supplies by rail to the classification yard near Chech'on, convoy wheels on Route BLACK, and occupy their positions in sector (see Map 10). If war breaks out before the corps leaves the staging areas, the commander will order the 208th Armored Cavalry Regiment to conduct a route reconnaissance of all five routes and establish a covering force area north of Expressway Four.

The L Corps commander's intent is for each division to rail move its reserve brigade's combat vehicles, maintaining unit integrity, and "HET move" a battalion's combat vehicles from the two lead brigades. To do this, the corps will allocate each division enough rail cars to move the tracked vehicles of one brigade plus 216 HETs. To reduce congestion, 52nd Infantry Division will have priority on one single-tracked rail line all the way from port to sector while the remainder of the corps uses the double-tracked main line. Transportation planners expect traffic control challenge and a security risk where the rail lines servicing four ports merge 50 kilometers north of Pusan at the rail junction of Samnanjin.

Using the march parameters established in one corps' current tactical SOP, it takes the corps 106 hours to establish the Wonju sector (see Appendix B). This is slightly longer than the X Corps required in 1951. In each of the previous case studies, the road march took one and a half times longer to execute than planned. Using this planning figure, it would take the L Corps six and a half days (159 hours) to move from staging areas to FAAs in sector.

The L Corps requires weeks to pass through the ports. In this scenario, movement planners provide only one half of the divided Expressway Four for routine resupply operations. Consequently, the corps would severely reduce resupply operations of other CFC units for nearly a week. Just why operational movement rates have not improved in a generation is the topic of the next section.

IV. DEFICIENCIES IN DOCTRINE, EQUIPMENT, ORGANIZATION, AND TRAINING

Operational movement is both an art and a science. This section concentrates on the science. Deficiencies in doctrine, equipment, organization, and training inhibit faster operational movements. Solutions are recommended for each of the deficiencies.

Doctrine

FM 71-100-1, Armor and Mechanized Division Operations: Tactics and Techniques, begins its appendix on tactical road marches,

There are no administrative movements in a tactical environment, whether moving from a sea or aerial port of debarkation . . . or a corps assembly area. Tactical movements assume that contact with the enemy will occur in some form en route or soon after arrival at the destination.⁶⁶

This remark confuses the distinction between types of movement and violates the movement principles of flexibility and use of maximum carrying capacity. This passage suggests that units march in combat formation once a war starts. The theater commander-in-chief (CINC) has to balance speed with security in a theater context. He might order a follow-on force to make an administrative move from ports to TAAs. This increases the speed of movement and makes more efficient use of transportation modes. CINC's will not order administrative moves if ground combat is anticipated en route. He is likely to risk administrative moves when threatened only with enemy air interdiction.

The CINC operational art is to create as many options as possible by adeptly positioning his force, and then rapidly generating combat power at the point of enemy vulnerability.⁶⁷ He articulates what forces move where, when, and how, to have a decisive battlefield effect. He maintains a balance of forces to respond to unforeseen

events. He decides whether rapid projection of available combat power or logistics build-up for overwhelming combat power with the capability of sustaining the force over a longer period of time will produce the result he desires.⁶⁸

Planning and executing operational movements is "science". Patton observed, "Since marching is a science, it is susceptible to more or less dogmatic treatment."⁶⁹ FM 100-5 of 1941 devoted 33 pages to motor, rail, air, and water transportation at the tactical and operational levels. FM 100-5 of 1993 has only one page addressing movement and it is in a tactical logistics context. Doctrine should specify how movements are planned and controlled. Training and Doctrine Command (TRADOC) should properly design, equip, and train planning staffs and movement control organizations consistent with operational movement doctrine.

There are five principles of movement: centralized control but decentralized execution; regulated movement; fluid and flexible movement; maximum use of carrying capacity; and forward support.⁷⁰ Doctrinal literature does not adequately address any of these principles. In practice, the U.S. military better applies these principles to rail, air, and water than to road movements.

Centralized movement control entails

... planning, routing, scheduling, controlling, coordination, and in-transit visibility [ITV] of personnel, units, equipment, and supplies moving over LOC and the commitment of allocated transportation assets according to command priorities.⁷¹

Operation staffs and movement control agencies at each echelon reconcile competing needs to move tactical units and routine resupply convoys over the same routes.⁷² TRADOC does not explain in any single manual how centralized control of road movement works. It addresses the concept in seven publications without explaining the process in its totality. Each echelon defines central control as control by their headquarters. This leaves it to corps, divisions, and brigades to explain how to develop movement orders and control movements in isolation. There is scant reference as to how each echelon adheres to parameters established by higher headquarters, or complements

central control. The movement principle of “centralized control, decentralized execution” should be modified to read: central planning, bottom-up refinement. TAMCA may develop block times and routes but each succeeding echelon should respond within a specified period of time with that echelon’s ability to execute the plan. Adjustments are made by either removing slack time or adding more time to the movement schedule.

The theater CINC has three movement control options: joint (or combined) control, single service control, or service component control. The most thorough and efficient use of movement assets from a theater perspective is joint movement control. The joint movement center (JMC) plans transportation, apportions tasks, forecasts requirements to the Defense Transportation System (DTS), acts on airlift requests, monitors sea deployments and “deconflicts” routes for all services and between allies.⁷³ Employing all transportation modes efficiently is the most effective way to conduct operational moves.

Unfortunately, the JMC is often not in place during the early stages of the campaign. The CINC may delegate a service component commander to control theater movements before the JMC establishes itself. Service components lack the links to DTS and could require more of CINC’s time to set inter-service, inter-ally priorities.

The most decentralized and expedient method is for the CINC to delegate movement control to all component commanders. This method works best when there are few units in theater. Because movement control units conduct echeloned deployments, tactical units usually control theater movements initially. As transportation battalions (movement control) arrive in theater, the CINC may more centrally control movements, freeing tactical units to focus on their own movements.⁷⁴ Because this method does not involve a movement control agency, the CINC establishes priorities between services or allies competing for logistical support and routes. Regardless of which movement control option the CINC chooses, the senior movement control headquarters prepares movement plans, coordinates with strategic and tactical movement elements, supervises subordinate movement control units and teams, and enforces effective use of available movement capabilities.⁷⁵

Within the theater framework, the Army controls moves through the theater army movement control agency (TAMCA). The TAMCA coordinates and administers transportation policy, manages operational moves and allocates theater transportation assets. It prepares movement and port clearance plans, conducts liaison with both higher and lower movement control elements, and commands the transportation battalions.⁷⁶

Movement control does not follow the normal hierarchical command chain or confine itself to traditional boundaries. In highway regulation, for example, the TAMCA controls brigade through army moves on theater movement or main supply routes (MSRs). It controls moves by placing its movement regulating teams (MRTs) at entrances and exits to theater MSRs. MRTs alone are insufficient to adequately control route movements. The CINC tasks major subordinate commanders to provide additional traffic control points (TCPs).⁷⁷

The TAMCA controls the communications zone (COMMZ) differently than MSRs. It usually divides the COMMZ into transportation regions based on number of supported units, available modes, and geography. Movement control teams (MCTs) belonging to the TAMCA's transportation battalions regulate movements by dealing directly with operators, shippers and receivers.⁷⁸ The CINC may relinquish movement control in the COMMZ to the host nation. Theater level may be the first common headquarters for all movement control elements that a tactical unit encounters. A unit moving from port to the battlefield could use routes controlled by different headquarters, or by the same headquarters using different control techniques.

The first corps to arrive in theater will probably precede the army service component command and the TAMCA. It is likely that the CINC will task the corps commander to control theater movements until a higher movement headquarters arrives. In this situation, the corps commander establishes priorities for logistical support and routes that support the CINC's intent. By the time the second corps reaches theater, it normally takes its movement instructions from a higher movement control headquarters.

In theater-controlled moves, corps do not move in isolation. The corps commander decides how best to integrate his move into the higher scheme. Successful

movements require anticipation, detailed planning, cooperation at all echelons, and "ruthless discipline".⁷⁹ Corps commanders consider the enemy-interdiction capability, quality of the transportation network, the impact of his move on higher headquarters' tactical operations, the relative advantage of limited visibility moves, the time to close in tactical positions, resupply and reorganization, and method of control.⁸⁰ He visualizes the effect such outside influences as displaced civilians, geography, or weather will have on his move. The commander directs reconnaissance of all primary, alternate, and cross-over routes and holding and assembly areas.

Movement planners determine how to move in accordance with the corps commander's intent.⁸¹ The staff dispatches competent and sufficient liaison teams, communicators, traffic controllers, and quartering parties to ensure rapid and fluid movement. Movement planners recommend routes, ground and air traffic control measures, and timelines to aid the commander in controlling the movement.⁸² Operations officers provide movement planners current unit locations, tactical and forward assembly areas, staging and holding areas, required arrival and closure times, sequence of combat, CS, CSS units and any special requirements.

Within the block times and routes that the TAMCA allocates, the corps sub-allocates space and time to subordinate units, establishes order of march, and devises reaction plans to enemy contact en route. The planners are constrained by number and types of vehicles, number and quality of routes, movement rate and available logistical support.⁸³ Corps should recommend adjustments to TAMCA's movement schedule at the earliest opportunity although doctrine does not require such action.

Corps planners need to appreciate what preparation divisions make to execute large-unit moves. Although the preparation mirrors that of corps, division movement plans require greater detail and therefore more time to produce. Corps tries to allocate at least three routes to each of its lead divisions. The division commander then makes decisions about his area of operation similar to those made by the corps commander and CINC. He analyzes his division's movement requirements, its organic and non-organic capabilities, and establishes priorities.⁸⁴ He determines the order of march based on his

mission, the enemy situation, subordinate unit march rate capabilities, his plan for additional CSS "lifts", implications of limited visibility movement, flexibility versus vulnerability, the degree the corps is exerting control over his division and the amount of control he desires over his subordinates. The division staff then plans the movement in detail. Preparation includes conducting reconnaissance, determining order of march and march data, protecting the move, providing logistical support, and establishing movement control.

The division conducts ground reconnaissance of the assigned routes and the dominating terrain while air reconnaissance covers the entire area of operation. The division normally assigns its cavalry squadron, engineer brigade, and military police company this mission. The reconnaissance force looks for possible lateral roads between assigned routes and parallel roads the main body could use to bypass obstacles or enemy contact. The reconnaissance force physically clears the route if it can. Divisions may dispatch combat forces if necessary to do this. Divisions send their advanced and quartering parties as soon as possible to provide them time to prepare the holding areas (HAs), TAA, and FAA.

To ensure the division conforms to the corps block time, division planners make numerous calculations. They determine march speed, catch-up speed, vehicle interval, march unit size, serial size, and intervals between march units and serials to ensure the division achieves its march rate and pass time. Planners also determine how often march units must halt to rest, refuel, conduct during operational maintenance and resupply. At these points, division establishes and secures holding areas (HAs) to allow room for dispersion, cover and concealment, and adequate ingress and egress.⁸⁵ Planners calculate how long it takes to conduct these holding area activities. Subordinate units provide division with the length of time it takes to reach and clear route SPs from their respective staging assembly areas or positions. Divisions use this data to refine their march planning and submit the information to the corps.

All of the movement data that corps and divisions compile has an impact on TAMCA's march schedule. The road movement planning process should allow time for

subordinate units to respond to its higher headquarters' movement plan. If an echelon cannot meet the march parameters (cannot move within a time block, cannot negotiate an assigned route, cannot support itself logistically, etc.), planners must make adjustments all the way up the chain of command.⁸⁶ This bottom-up refinement ensures march tables are realistic. Only with refined movement orders can commanders accurately anticipate when and in what condition his fighting forces will arrive at the critical point on the battlefield.

FM 100-16 defines the principle of forward support as fast and reliable transportation assets capable of moving soldiers and supplies as far forward as possible.⁸⁷ Transportation is only part of forward support for operational movements. Operational logistics and positioning of tactical command and control, CS, and CSS assets play a dominant role. Operational logistics receives strategically-deployed units and develops infrastructure so that they can move fluidly from ports to the combat zone.⁸⁸ Like movements in general, operational logistics relies on continuous communication, total asset visibility (TAV) and ITV to function effectively.

In 1987, Major General L. D. Holder, then a lieutenant colonel and chief war planner for III Corps, developed a concept known as "sling shot" that has since become doctrine. It stresses positioning command and control, CS, and essential CSS forward astride the movement routes to free the roads for subordinate tactical units.⁸⁹ Using such a technique, the corps could move to contact its fighting force with minimal delay. The reserve and remaining CSS units would follow in the wake once the routes cleared. Another option is for the corps reserve to move first and occupy an FAA short of line of departure (LD) or move in a tangential direction as part of the corps deception plan.⁹⁰

The object of the sling shot concept is to move the largest tactical units possible through theater without forcing them to consume their own logistics before entering the combat zone. As currently structured, the Theater Army Area Command (TAACOM) cannot support corps movements without substantial augmentation from the Corps Support Command (COSCOM). In practice, the Division Support Command (DISCOM) supports its own division during corps moves. In some circumstances, the DISCOM

provides logistical support for the entire corps preventing it from moving with its division until the corps finishes moving. With assistance from stationary units astride the movement routes in the combat zone and host nation assets in COMMZ, divisions might be able to keep unit integrity during operational moves. These in-place units could provide medical, vehicle recovery, maintenance, fueling, HET, traffic control, route repair, and bridging support to the moving force.⁹¹ Doctrine should emphasize the sling shot concept from theater and corps level, not at division and below.

Equipment

Movement control agencies are not equipped to accomplish their task. The 318th Transportation Agency in DESERT SHIELD, for example, lacked the communications and automation equipment of their equivalent civilian counterparts. Because emission control is a critical part of OPSEC during operational moves, MRTs and TCPs use telephones as primary means of communication. The STU-III telephone and the older "Parkhill" device are two pieces of army equipment that secure telephone lines. The 318th owned neither. Instead, they rented commercial cellular phones that though were secure against unsophisticated collection means only. The 318th also did not have Mobile Subscriber Equipment (MSE) or Pulse Code Modulation so it could not communicate directly with most tactical units moving on its routes. The 318th relied on high frequency AM radios to talk over extended distances and hand held FM radios for TCPs to contact moving units.⁹² Movement control units need MSE to communicate with units marching 150 kilometers, the average roadmarch distance. They need tactical satellite (TACSAT) radios if intervening terrain blocks FM signals.

Movement control lends itself to automation, yet the army has done little toward this end. To reduce electronic emission, divisions resort to such techniques as march unit commanders handing three-by-five cards to TCPs to report progress.⁹³ The labor intensive and time consuming system of monitoring movements by physically manning control points along the routes can be simplified using existing electronic equipment. Satellites, Joint Stars, ground surveillance radars, and seismic and video sensors could monitor operational movements. Helicopters working for the movement commander

could shepherd errant march units. MRTs would still be necessary to physically control the entrances and exits to routes, but the number of intermediate TCPs could be significantly reduced by electronic monitoring means.⁹⁴

A system used by American railroads for the past 25 years has applicabilty for military movement control. Centralized Traffic Control (CTC) uses sensors to detect position of all trains on a particular line (route). These sensors are linked to a computer that automatically controls signals and turnouts (to switch tracks) to ensure that trains maintain precise spacing and even speeds. Tracksides infra red bar code scanners give control towers constant ITV. Portable roadside sensors and scanners combined with built in vehicle bar codes would provide CPs the same precise control of movements and ITV of supplies as railroad control towers. Even a white and infra red light signal system has utility in military movement control.

Electronic message boards similar to those constuction companies use when building new roads would further improve movement control. Movement control agencies could instantly flash speed restrictions, route information, and even directions for specific serials on the boards. Language translation software for control headquarters' computers would allow U.S. soldiers to post information for allied convoys. Multi-lingual message boards would reduce the requirement for allied liaison personnel.

The U.S. Army does not have enough HETs, lowboys, stake and platform tractor-trailors, MHE, or portable truck or rail car off-load ramps in the active army to move a corps in one lift. The army should use Force Analysis Simulation of Theater Administrative and Logistics Support (FASTALS) to determine what the requirement is to produce a desired outcome. AMC should procure the minimum essential equipment to accomplish its missions. Reserve units, allied units, host nations, or commercial sources could provide the remainder of the equipment, but only if the army makes arrangements before crises occur.

Current U.S. Army armored units cannot take advantage of the speed of their newest vehicles because of older generation equipment in the organization. Several CS

and CSS vehicles in the army inventory slow march rates. Within battalions, recovery, fire support team, and engineer vehicles cannot keep up with M1 Abrams tanks and M2 and M3 Bradleys. Although M109A6 howitzers, Multiple Launch Rocket Systems (MLRS), Bradley Stinger Vehicles and Avengers enable artillery and air defense units to keep up with the tank and mechanized infantry battalions in the brigade, combat engineer units cannot. Serials can march only as fast as their slowest vehicles.

Although combat engineer squads operating M113A3 carriers can stretch and keep pace, several other engineer battalion vehicles cannot. Some older generation vehicles will remain in the force structure for the indefinite future. Both the Combat Engineer Vehicle and the Armored Vehicle Launched Bridge are based on M60 chassis that cannot keep up with modern vehicles either on or off the road. The M548-drawn ground emplaced mine scattering system (GEMSS) is slow and lacks adequate cross-country mobility.⁹⁵ The Armored Combat Earthmover (M9, ACE), though a recent procurement, had difficulty specified maintaining march rates during DESERT SHIELD.

The solution for the first two vehicles is to replace them with M1 chassis-based systems. The Volcano mine layer based on a Bradley chassis will eventually replace the GEMSS. AMC must either modify the ACE or, a less appealing but less expensive solution, place it on a lowboy like its predecessor, the D7 bulldozer. Until the slower tracked vehicles are purged from the inventory, corps will continue to move at 1942-1953 rates.

Modern equipment is not without movement constraints. For example, the M1 tank consumes too much fuel and has limited range. On improved surfaces, it consumes three gallons per kilometer. Even though the M1 has a 300 kilometer range, if it is not fuelled before it begins drawing from its forward fuel tanks, ROMs become prohibitively long in duration. Consequently, tanks should be refuelled approximately every 150 kilometers even though accompanying vehicles do not require much fuel. The more ROMs, the slower the movement rate.⁹⁶ To solve the problem, industry has developed both a more fuel efficient gas turbine engine and a diesel substitute. Budget constraints make these solutions unlikely. As an expedient, AMC could affix a fuel bladder to the

engine access deck to provide the M1 enough extra fuel to match the Bradley range. This would reduce the number of ROMs required enroute.

Organization

Movement control lacks unity of effort and unity of command. Most operational movements tend to be tactical rather than administrative. This means they are controlled by J-3s or G-3s. Unfortunately, the agencies that have the route control teams and communications all work for support commands. Because there is no command linkage between echelons of logistics units, effective movement control relies on coordination. For example, if the GCC directs his J-3 to control the move of a reinforcing corps through theater, the J-3 planners may write the order, but the TAMCA produces the march table and Highway Traffic Division of TAMCA monitors the movement. The corps G-3 planners, in turn, publish a movement order based on the GCC's order with the march table developed by COSCOM's MCC. MRTs subordinate to the corps MCC regulate the flow of traffic on the routes.

The division organization for planning movements is even more convoluted than higher headquarters. The G-3 planners produce the order for which the division transportation officer (who works for the G-4) completes the march table. The TCPs physically controlling the execution work for DISCOM's MCC. For routine logistics resupply convoys, regional corps MCTs control movement by region and division MCC controls the moves within division boundaries.⁹⁷

In 1992, General Jimmy D. Ross, then commanding U.S. Army Materiel Command, advocated combining the DTO with MCC. This new organization would be located with the materiel management center to provide a "one-stop" division transportation and distribution center.⁹⁸ Lieutenant Colonel Wykle from U.S. Transportation Command acknowledges that the Army staff is in the process of changing the force structure to combine the DTO and the MCC. This solution is only the first step to solving the unity of effort problem. Having the division MCC work for the G-3 in planning and supervising execution of operational movements would simplify movement

control. Only if movement planners and controllers work for the operators at all echelons, can the problem be resolved.

U.S. Army heavy truck companies are not organized optimally to support operational movement. The company organic to heavy divisions contains 24 HETs and 24 drivers. Non-divisional companies have 36 trucks and 36 drivers. The priority mission for these companies is evacuation of severely damaged combat vehicles to maintenance support sites. Moving tracked vehicles is secondary. Divisions can lift one march unit organically, but this effort would have a minor impact on a division move as a whole.⁹⁹

In 1992, Joe Fortner, Captain Jules Doux, and Captain Mark Peterson, all from the U.S. Army Transportation School's Directorate of Combat Developments, proposed a solution to the HET organization problem. They recommended divisional HET companies of 96 HETs, two drivers per HET, and a direct support maintenance platoon. The primary mission of this company would be transport. It would be capable of 24-hour operations.¹⁰⁰ This would enable divisions to lift a task organized serial or all the tanks of a brigade. With 96 vehicles organic to a company, command and control, roadmarch discipline, and logistical support would be better than for a similar number of HETs from various units. Whether this 96-HET company is organic to the division or a higher echelon is not important, but the ability to maintain serial integrity is. The active army needs enough companies to support itself without relying on activation of reserve component companies. In short-notice conflicts, reserve units may not be available at the critical time and place.

The Army should consider organizing certain units for speed to cover the move of following units. Peter Kindsvatter advocated "flying columns" in 1986 when only Abrams tank and Bradley Fighting Vehicles could sustain a 55 kph march rate within divisions.¹⁰¹ Artillery, air defense, and engineer units could not keep up. With the exception of certain combat engineer vehicles, modern equipment makes the flying column concept more feasible than ever. This organization's mission would be to swiftly

clear the routes and secure the FAAs. This would enable the rest of the corps to move at the maximum possible march rate.

Training

National Training Center (NTC) take-home packages from October 1991 to March 1993 indicate that march unit interval and punctuality were erratic.¹⁰² The root of this problem is battalion training at home station. With limits on the number of miles tracked vehicles can drive in a year, battalion road march training might not represent a high priority training event. There are few large unit training events such as REFORGER where all echelons practice execution of a road march table. Even routine gunnery training does not offer the roadmarching possibilities it once did. To save money, battalions often reduce the number of vehicles they send to ranges or shuttle their vehicles on a small number of HETs. Simulation Networking (SIMNET) offers crewmen through battalion staff some road march training. If practiced prior to a field training exercise, simulation can improve the quality of training.

TRADOC does not systematically train movement planning. The only school that incorporates a movement exercise is the School for Advanced Military Studies (SAMS), and this is at the brigade level. Because most brigade and battalion movements are planned by officers with only advanced course or combined arms and services staff school experience, a brigade-level exercise should be part of those schools' curriculum. Command and general staff college students should review brigade movements and train a division exercise in detail. SAMS students should review division movements and train at the corps level. War colleges should plan all aspects of a theater movement from division to army. With each TRADOC school building on the experience of its predecessor all within a common doctrinal framework, movement planning would improve.

TRADOC should incorporate operational movements in the Battle Command Training Program (BCTP). Early versions of the Corps Battle Simulation (CBS) often

“crashed” when operators entered voluminous movement commands. The current version of CBS software can handle such movements. BCTP is one of the few opportunities corps get to train operational moves. TRADOC should make movements a mandatory mission for corps BCTP even if it requires increasing exercise length.

Large-unit exercises such as REFORGER train planners in operational movement. These exercises regularly include reserve component and host nation transportation units that are essential to large-unit movements. Reduced operating budgets will limit the number and scope of future exercises, but exercise designers should preserve operational movement missions.

Fortunately, training deficiencies are the easiest to correct. If “moving” were on mission essential task lists at all echelons, units would have more collective, joint, and combined training opportunities. Although they do not duplicate battlefield friction, simulations acquaint soldiers with the complexity of operational movements and improve the quality of the rarer opportunities for physical movement training.

V. CONCLUSION

The movement of major combat, combat support, and combat service support units to the decisive place and time on the battlefield is the commander’s operational art. Effectively integrating, controlling, and supporting motor, rail, air, and water modes of intratheater transportation is “science”. Despite the greater speed of the vehicles, trains, aircraft, and ships involved, statistical comparisons between World War II and Korean War campaigns and recent actions in similar terrain indicate U.S. corps have not improved their ability to conduct operational movements. In desert terrain, Operation DESERT STORM’s VII and XVIII Corps did not move to their forward assembly areas any faster than elements of First Army or II Corps did during Operation TORCH. In urban terrain, REFORGER’s III Corps did not move faster than its predecessor during the Ardennes offensive. In mountainous terrain, time-distance analysis shows that an armored reinforcing corps could not move from port to sector as rapidly as X Corps did in defending Line D. Deficiencies in doctrine, equipment, organization, and training inhibit corps from increasing their movement rate.

The five principles of movement, centralized control/decentralized execution, regulated movement, fluid and flexible movement, maximum use of carrying capacity, and forward support, challenge operation staffs and movement control agencies. Concerning the first principle, the theater CINC has three movement control options: joint (or combined) control, single service control, or service component control. The JMC makes most efficient use of theater transportation assets and centrally controls moves. Single service movement control is a viable interim solution. The most decentralized and expedient method is for the CINC to delegate movement control to all component commanders.

Within the theater framework, the Army controls moves through the TAMCA. If the first corps to arrive in theater precedes TAMCA, that corps will probably control its own movements. In theater-controlled moves, however, corps do not move in isolation. Within the block times and routes that TAMCA allocates the corps, the planners sub-allocate space and time to subordinate units, establish order of march, and devise reaction plans to enemy contact en route. The numerous calculations that corps and divisions make in movement planning impact on the TAMCA's march schedule. Doctrine should stress that timely feedback from tactical units ensures realistic movement expectations. The principle of forward support is critical to the success of operational movements. A concept known as "sling shot" stresses forward-positioning command and control, CS, and essential CSS astride the movement routes so that the largest tactical units possible can move quickly through theater.

TRADOC has not equipped movement control agencies, combat units, or CSS units to control, support, or conduct operational movements effectively. MCAs do not have the communications or automation equipment to accomplish their task. These agencies need MSE, TACSAT, and an integrated computer system that monitors and gives electronic instructions to moving units.

The U.S. Army does not have enough HETs, lowboys, stake and platform tractor-trailers, MHE, or portable truck or rail car off-load ramps in the active army to move a corps in one lift. Finally, armored units cannot take advantage of the speed of their

newest vehicles due to older-generation equipment in the organization or new equipment deficiencies. Combat engineer equipment, in particular, has difficulty keeping pace. Modern equipment has problems, too. For example, the ACE is too slow and the M1 tank consumes too much fuel and has limited range.

The Army has not optimally organized its forces to centrally control, support, or conduct operational movements. Combining movement planning and movement control under the operations sections at each level will improve unity of effort. HET units do not have enough trucks or drivers to support operational movements. The Army should consider organizing certain units for speed to cover the move of following units, the so called "flying column" concept.

Tactical units do not train in operational movements. From battalion through corps, march discipline is erratic. TRADOC does not systematically train officers in movement planning. It should train each echelon of movement at each echelon of officer education from advanced courses through war colleges. TRADOC should also incorporate operational movements in the battle command training program (BCTP). Large-unit exercises, though less frequent than last decade, should keep operational movements as primary exercise objectives. Fortunately, training deficiencies are the easiest to correct.

Current U.S. Army doctrine is not specific or holistic enough to be treated as a science. Doctrine becomes more vague as movements become more complex. Doctrine does not prescribe equipment, organization, and training necessary to support faster movements. Equipment deficiencies complicate movement control. Systematic large-unit training, which peaked with the semi-annual REFORGER exercises in the 1980s, has declined. Computer exercises and the battle command training program in particular, have not compensated for the loss of large-scale field training exercises. Logistics infrastructure shortcomings greatly inhibit the theater army command's onward movement capacity.

The U.S. Army's inability to increase its operational movement rate is not important in itself, but in relation to the movement capability of the enemy. If CINCs

base their war plans on unrealistic movement rate assumptions, friendly or enemy, those plans are untenable. Army organizations might have more ground vehicles than they can bring to bear against the enemy. More effective organizations may be smaller or rely on aviation assets to generate combat power rapidly at the critical points on the battlefield.

ENDNOTES

- ¹ Headquarters, Department of the Army, FM 100-5, Operations, (June 1993), p. 12-12.
- ² Headquarters, Department of the Army, FM 100-15-1, Corps Operations, Tactics and Techniques, (Unedited Coordinating Draft, April 1991), p. 22-1.
- ³ Carl von Clausewitz, On War, (Princeton, New Jersey: Princeton University Press, 1976), p. 314.
- ⁴ Ibid, p. 325.
- ⁵ Edward M. Earle, Makers of Modern Strategy: Military Thought from Machiavelli to Hitler, (Princeton, New Jersey: Princeton University Press, 1943), p. 289.
- ⁶ J.F.C. Fuller, The Foundations of the Science of War, (Fort Leavenworth, Kansas: USACGSC Press, 1993), p. 259.
- ⁷ Ibid, p. 335.
- ⁸ Ibid, p. 86.
- ⁹ Ibid, p. 149.
- ¹⁰ FM 100-5, p. 2-5.
- ¹¹ Headquarters, Department of the Army, FM 101-5-1, Operational Terms and Symbols, (Initial Draft, January 1994), p. 1-146.
- ¹² FM 100-5, p. 2-5. FM 101-5-1 does not make a distinction between operational maneuver and operational movement (p. 1-146).
- ¹³ Headquarters, Department of the Army, FM 100-7, The Army in Theater Operations, (Edited DRAG version, December 1993), pp. 4-1, 4-3.
- ¹⁴ Ibid, pp. 4-1, 4-4.
- ¹⁵ FM 100-15-1, p. 22-1.
- ¹⁶ Ibid.
- ¹⁷ Headquarters, Department of the Army, FM 100-16, Army Operational Support, (Final Approved Draft, February 1995), p. 5-21. The 1941 version of FM 100-5 calculated that because the average division required four hours to entrain, that rail transport was not efficient for movement of less than 150 miles. Planners still use this factor. FM 100-15-1 states that units making trips of shorter duration should use roads. In restrictive terrain or when there is a shortage of drivers, trains may be critical to clearing port facilities even if they move equipment only as far as the staging area. (FM 100-15-1, p. 23-7)
- ¹⁸ As early as October 1941, British Prime Minister Winston Churchill considered landing forces in Morocco, Algeria, and Tunisia as the anvil against which General Claude Auchinleck's Operation CRUSADER hammer would defeat decisively Rommel's *Panzer Armee Afrika*. Churchill secured President Roosevelt's support for additional shipping and troops for seizure of Tunisia at the December 1941 Arcadia Conference. Unfortunately, CRUSADER culminated at Agheila rather than its objective 500 miles to the

West, Tripoli. The Second World War: Europe and the Mediterranean, (West Point, New York: USMA, 1979), p. 332-333.

¹⁹ Ibid., p. 334.

²⁰ Ibid., p. 335.

²¹ First, local French commanders at Oran and Casablanca resisted allied landings because Darlan gave them no guidance to the contrary. Second, the local commander scuttled the French fleet at Toulon because Darlan could not decide whether to offer it to the Allies before the German army was about to seize it. The fleet could have provided the Allies invaluable sea LOC security for intratheater shipping. Last, local French commanders relinquished the airfields and ports around Bizerte and Tunis to their supposed German Allies because Darlan did not order them to resist. Ibid.

²² Ibid.

²³ On 17 November, the day First Army made contact with German Fifth Army, the British Eighth Army approached Benghazi. Having broken through the Axis defenses at El Alamein on 5 November, Eighth Army was advancing westward at 80 kilometers a day. The entire pursuit to the Mareth line in Tunisia was 30 kilometers a day (2640 miles in 90 days) including two Axis delaying actions at El Agheila and Buerat.

²⁴ George F. Howe, The Battle History of the 1st Armored Division-"Old Ironsides", (Washington, D.C.: Combat Forces Press, 1954), p. 51.

²⁵ Ibid., pp. 52,53.

²⁶ Ibid., pp. 53,54.

²⁷ Ibid., pp. 54.

²⁸ George F. Howe, op cit, p. 96.

²⁹ Joseph Bykofsky and Harold Larson, The Transportation Corps: Operations Overseas, (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1957), p. 152.

³⁰ Ibid., p. 162.

³¹ Ibid., p. 168.

³² Ibid., p. 162.

³³ Ibid., p. 166.

³⁴ Richard M. Leighton and Robert W. Coakley, Global Logistics and Strategy, 1940-1943, (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1955), p. 469.

³⁵ Joseph Bykofsky and Harold Larson, op cit, pp. 169, 170.

³⁶ Ibid., pp. 162, 164.

³⁷ Facts collated from both George F. Howe, op cit, p. 228, and Joseph Bykofsky and Harold Larson, op cit, p. 167.

³⁸ Peter S. Kindsvatter, An Appreciation for Moving the Heavy Corps--The First Step in Learning the Art of Operational Maneuver, (Fort Leavenworth, Kansas: SAMS monograph, 1986), p. 6. This monograph provides a detailed description of II Corps' movement including a reconstructed corps march table.

³⁹ Ibid. p. 7.

⁴⁰ Ibid. pp. 8-13. Third Army initiated the III Corps' operational move with verbal orders backed by a one-page written order on 20 December. III Corps issued no movement orders and 4th Armored Division was the only subordinate command to do so. This was possible because the standard operating procedure (Third Army Circular No. 10) was well practiced by III Corps. (Ibid. p. 12.)

⁴¹ Michael D. Burke, Extracting The Beaten Expeditionary Force: The Margin etween Defeat and Catastrophe, (Fort Leavenworth, Kansas: SAMS monograph, 1986), p. 33.

⁴² Elements of the 7th Infantry Division and the 1st Korean Marine Regiment participated initially in this perimeter defense too.

⁴³ Michael D. Burke, op cit, p. 32.

⁴⁴ Facts collated from Clay Blair, The Forgotten War, (New York: An Anchor Press Book, 1987), p. 170, and Billy C. Mossman, Ebb and Flow, November 1950-July 1951, (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1990), p. 545.

⁴⁵ Billy C. Mossman, op cit, p. 167. Part of the evacuation's success can be attributed to Colonel E.R. Forney, the beachmaster at Hungnam, who maintained discipline and central control of embarkation.

⁴⁶ Ibid. p. 106.

⁴⁷ Ibid. pp. 185, 197.

⁴⁸ James A. Huston, The Sinews of War: Army Logistics, 1775-1953, (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1966), p. 644.

⁴⁹ Ibid.

⁵⁰ Ted A. Cimral, "Moving the Heavy Corps," Military Review, July 1988, p. 218.

⁵¹ Ibid. p. 223.

⁵² Robert Fiero, the III Corps G-3 during REFORGER 1987.

⁵³ Iraqi missiles were not accurate enough to threaten convoys or trains, although they caused some anxiety at the ports.

⁵⁴ Richard M. Swain, "Lucky War", Third Army in Desert Storm, (Fort Leavenworth, Kansas: USACGSC Press, 1994), p. 157.

⁵⁵ Ibid. p. 165.

⁵⁶ Ibid. p. 157.

⁵⁷ Ibid. p. 165.

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- ⁵⁸ Ibid, p. 160.
- ⁵⁹ Peter C. Langenus, "Moving an Army: Movement Control during Desert Storm," Military Review, September 1991, p. 43.
- ⁶⁰ Desert Storm, 1st Armored Division After Action Review Slide Briefing, 1991, slides 13 & 18.
- ⁶¹ Peter C. Langenus, op cit, p. 44.
- ⁶² John M. Britten, "Army Support Force Generation: The Baskin-Robbins Analogy," Military Review, June 1991, p. 78
- ⁶³ Reception, Staging, Onward Movement, and Integration-Operations: Quick Reaction Analysis, U.S. Army Concepts Analysis Agency, May 1994, p. 5.
- ⁶⁴ U.S. Army Command and General Staff College, ST 101-6, G1/G4 Battle Book, (June 1994).
- ⁶⁵ TOE 7 versus TOE 87004J42.
- ⁶⁶ Headquarters, Department of the Army, FM 71-100-1, Armor and Mechanized Division Operations: Tactics and Techniques, (Coordinating Draft, May 1991), p. B-1.
- ⁶⁷ FM 100-5, p. 3-11.
- ⁶⁸ Ibid, p. 3-10.
- ⁶⁹ Paul F. Gorman, The Secret to Future Victories, (Fort Leavenworth, Kansas: Combat Studies Institute, USACGSC, 1992), p. II-28.
- ⁷⁰ FM 100-16, pp. 5-7, 5-8.
- ⁷¹ Ibid, p. 5-3.
- ⁷² Movements require synchronization of movement control, maneuver control, and battlefield circulation control. (Ibid, p. 5-4.) Battlefield circulation control, a major military police mission, supports both maneuvers and movement by providing continuous route reconnaissance and traffic control. Synchronized operational moves do not present the enemy lucrative massed targets and reduce the time to conduct the move. (FM 100-15-1, p. 23-7.) Sensors, surface-to-surface missiles, and air-delivered precision-guided missiles in the hands of an increasing number of potential enemies makes fluid and flexible movement crucial. (Headquarters, Department of the Army, FM 100-15, Corps Operations, Initial Draft, July 1994, p. 8-29.)
- ⁷³ FM 100-16, p. 5-5.
- ⁷⁴ Ibid, p. 5-8.
- ⁷⁵ Ibid.
- ⁷⁶ Surface transportation or airlift requests require 48 hours (72 for host nation assets) to process. Corps make road movement bids to TAMCA. Approved bids detail type and capacity of transportation assets and become road movement credits. (FM100-15-1, p. 23-1.)
- ⁷⁷ These normally come from units making the move. Units man assigned TCPs until the last vehicle in that unit passes. Then soldiers from the next unit replace them and so forth. If necessary, TCPs can

communicate with passing units by FM radio but must rely on telephone or mobile subscriber radio telephone (MSRT) to relay movement information to TAMCA.(FM 100-15-1, p. 23-4.)

⁷⁸ FM 100-16, p. 5-8.

⁷⁹ FM 100-15, p. 8-22.

⁸⁰ Ibid, p. 8-23.

⁸¹ FM 100-15-1, p. 23-7.

⁸² Ibid, pp. 8-26, 8-30.

⁸³ FM100-15-1, p. 27-2. To observe operations security (OPSEC), only brigade or larger units report start points (SPs), phase lines (PLs), and release points (RPs) via radio. Whoever makes enemy contact or has route information requiring immediate action by following units reports it via FM radio. The TCPs make all routine reports by secure telephone that enable corps MCC (and through its MRTs, TAMCA) to monitor movement progress. Divisions protect their moves through OPSEC, deception, and physical security. Because higher headquarters normally selects the routes, division OPSEC amounts to electronic emission control. A discussion appears in the command and control paragraph. Deception normally requires the division to participate in a corps or theater scheme. Physical security may require the division to augment theater air defense with elements from its air defense battalion. The division may preposition its corps artillery units to provide responsive fire support to the move or the initial fight so that division artillery (DIVARTY) with its direct support battalions may continue to march with the brigades they support. Flank security remains a division responsibility through the operational move. Because division cavalry normally seeks to find the enemy for the upcoming fight, division usually tasks brigades to provide flank or rear security for the division formation.

⁸⁴ Ibid, p. 22-7. The division commander may find higher headquarters controlling his battalions' movement or he may have only a block time and designated routes. In either case, the division commander case the commander decides how much control (or additional control) to exert over his division. The traffic circulation plan designates route designation and restrictions, location of MRTs and TCPs, direction of movement, geographic features of routes, and location of temporary traffic signs. The tactical command post usually controls division moves. It sets up well forward to be able to communicate by FM radio with brigades where they are likely to join the battle. In one division, the Assistant Division Commander for Support controls operational moves from the rear command post (CP) to free the main and tactical CPs to prepare for the upcoming fight. In this technique, DISCOM coordinates area support for the division while each of the forward support battalions provide MRTs and TCPs for the route over which its brigade travels. If the division has to support itself logistically, this technique has the advantage of employing the headquarters whose units are pre-positioned and stationary. The DISCOM tends to provide soldiers to operate the TCPs and secure HAs. Once the brigades and DIVARTY reach their FAAs, the DISCOM will still control the routes until the subsequent CSS lifts are complete.

⁸⁵ FM 71-100-1 suggests MPs and the division band provide local security, but any unit could do this.

⁸⁶ There are many factors that retard march rates: steep grades, sharp turns, populated areas, slippery surface conditions caused by dust, ice snow, or mud, experience, training and fitness of drivers, total number of vehicles, and visibility. Enemy contact also slows movement rates. Divisions establish a threshold of enemy resistance that requires a division reaction. The division tries to fight through ambushes or sniper attacks and quickly return to the road march schedule. When the resistance is too great for the unit in contact to overcome, then the division directs other subordinate units to come to its assistance. Brigades beyond the ambush may continue to march or double back and attack the "ambushers". Trail units either render assistance to the ambushed unit or disperse in HAs closes to their locations. The level of detail and

degree of training proficiency of the brigades will determine whether the division can resume its march without disturbing the corps operational move schedule.

⁸⁷ FM100-16, p. 5-8.

⁸⁸ FM 100-5, p. 12-2.

⁸⁹ This concept is embodied in FM 100-15-1 on page 22-9. Corps can provide area air defense, engineer, and military police support from organic assets. This enables moving divisions to retain unit integrity and freedom of action. Corps may direct divisions to organize flexible formations that provide their own flank security while moving and enable rapid transition to tactical action. (FM 100-15, p. 8-32.)

⁹⁰ Colonel L.D. Holder and Major Edwin J. Arnold, "Moving the Heavy Division," Military Review, July 1988, p. 44.

⁹¹ FM 100-15-1, pp. 22-5, 22-6.

⁹² Langenus, op cit, p. 47.

⁹³ One division has the commander of each march unit extend a three by five inch card with his unit and pertinent information written on it to soldier at each TCP. This enables march unit commanders to report without using the radio. It also prevents the TCP from missing the unit markings during limited visibility.

⁹⁴ Division publishes a movement order and traffic circulation plan complete with strip maps because a majority of division vehicles lack topographical maps. The movement order explains how marching units are to communicate their progress to TCPs and the controlling command post. Normally reporting below brigade level is by exception only. All units enforce radio listening silence. TCP reporting of passing units generally suffices for the CP to monitor the move.

⁹⁵ The M548 is a cargo derivative of an early version of the M113 personnel carrier. Even when not pulling the GEMSS trailer, it cannot maintain the march rate of the M113A3s in the Engineer Battalion.

⁹⁶ Because the tanks consume similar amounts of fuel whether idling or moving and start ups consume the equivalent of 20 minutes of fuel, tanks do not conserve fuel unless halts are longer than 20 minutes. The average refuel time from entering site unit exiting is 40 minutes. 1st Armored Division AAR, op cit, slide 22.

⁹⁷ Kindsvatter, op cit, pp. 33-34. Additionally, traffic headquarters exchange conducts liaison to share convoy data.

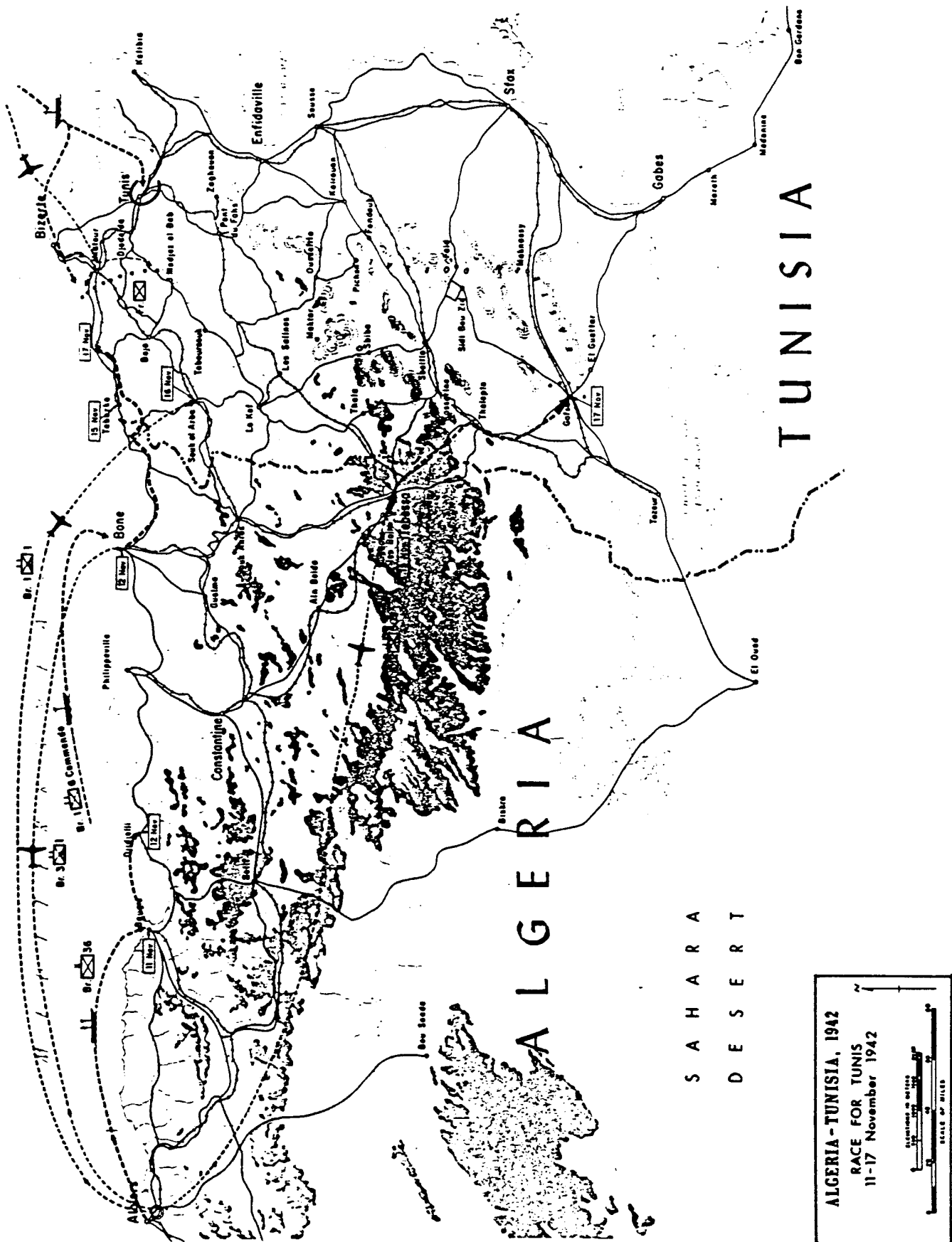
⁹⁸ General Jimmy D. Ross, "Focusing Logistics for the Future," Military Review, September 1992, pp. 53-54.

⁹⁹ Joe Fortner, Captain Jules Doux, and Captain Mark Peterson, "Bring on the HETs," Military Review, January 1992, p. 36.

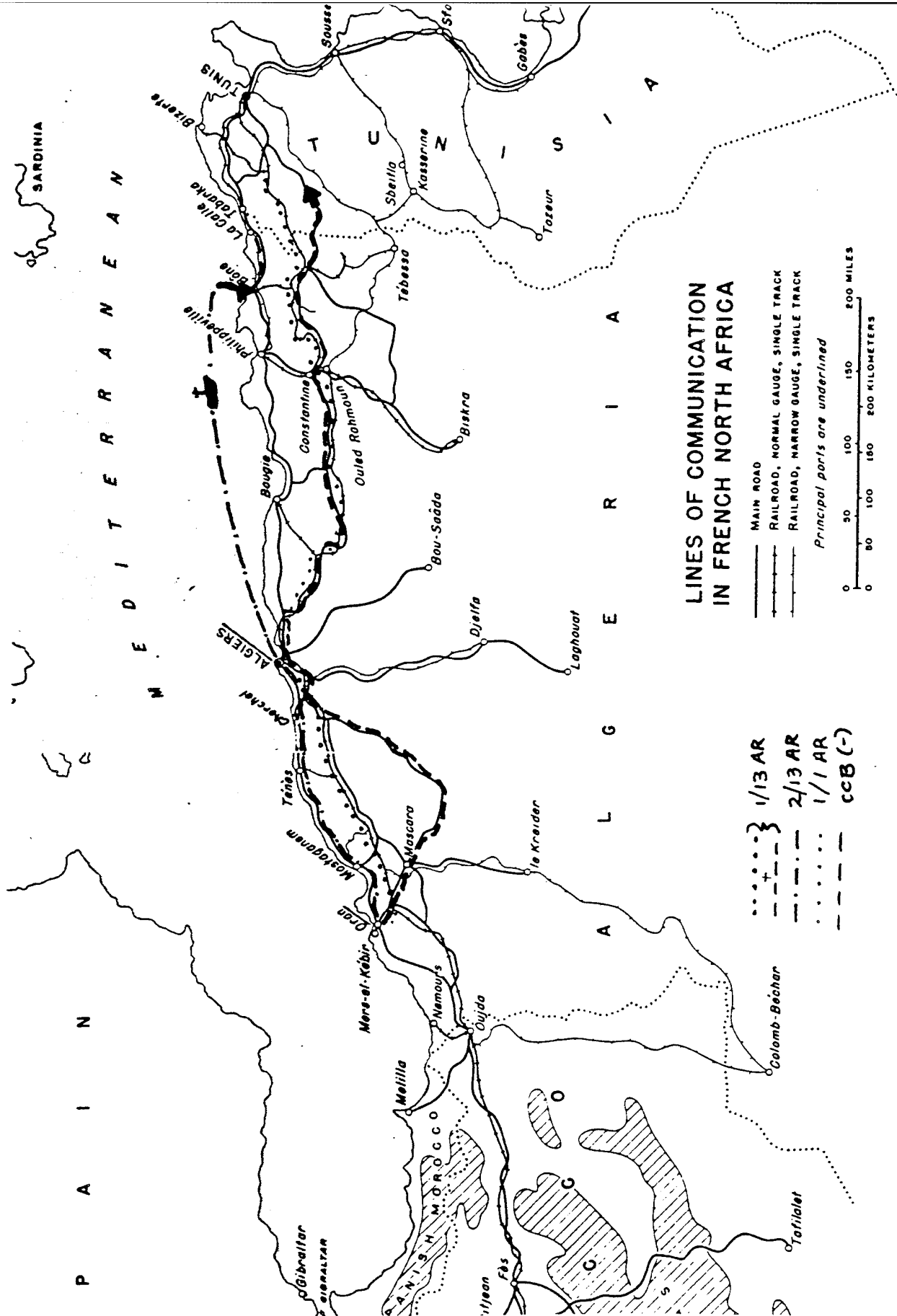
¹⁰⁰ Ibid.

¹⁰¹ Kindsvatter, op cit, p. 32.

¹⁰² Headquarters, National Training Center, Take-Home Packages, (Fort Irwin, California: October 1991 to March 1993), found in the Combined Arms Automated Archive, Fort Leavenworth, Kansas.

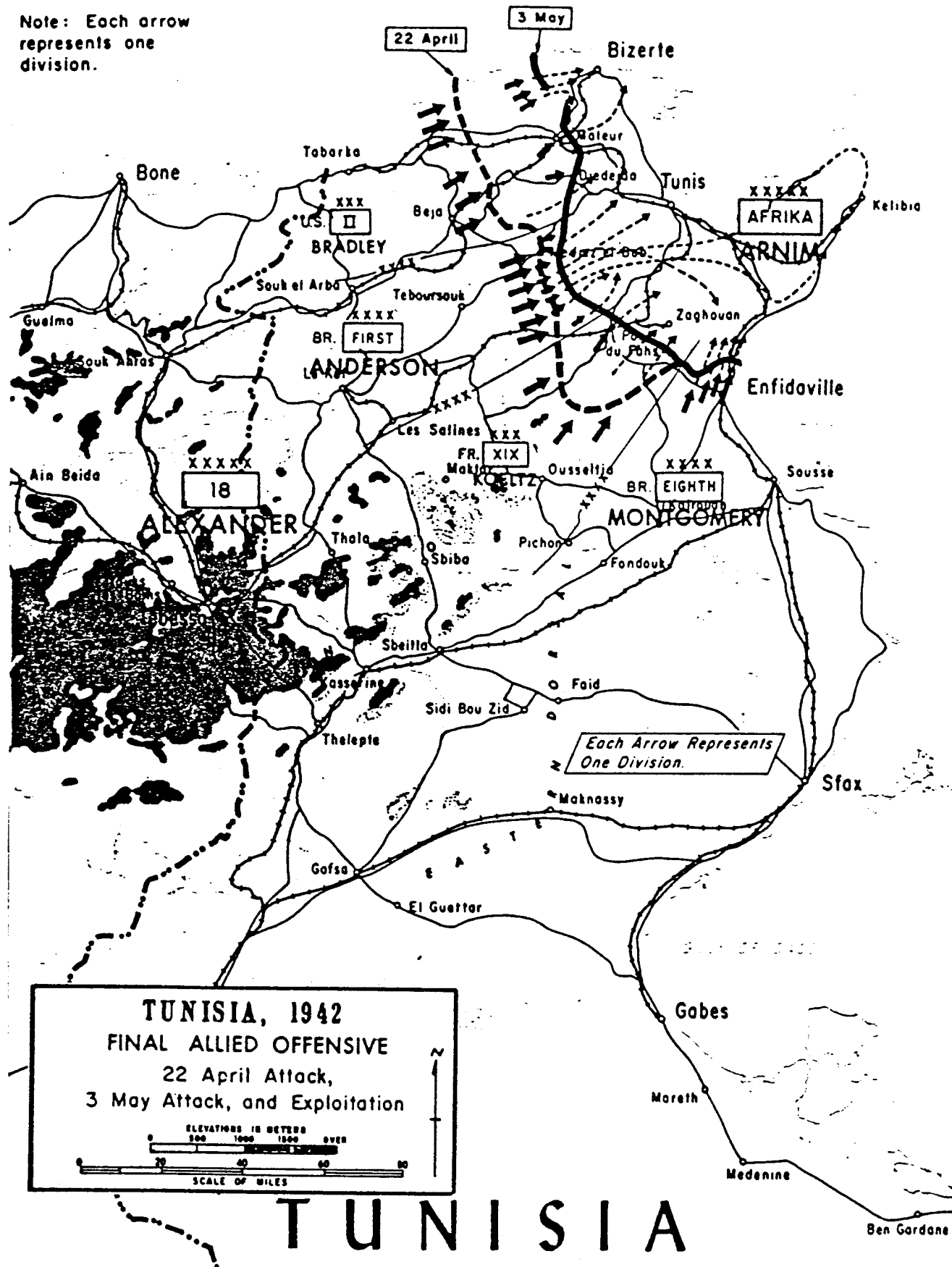


MAP 1: Third Army's Operational Movement, 8-22 February 1942.

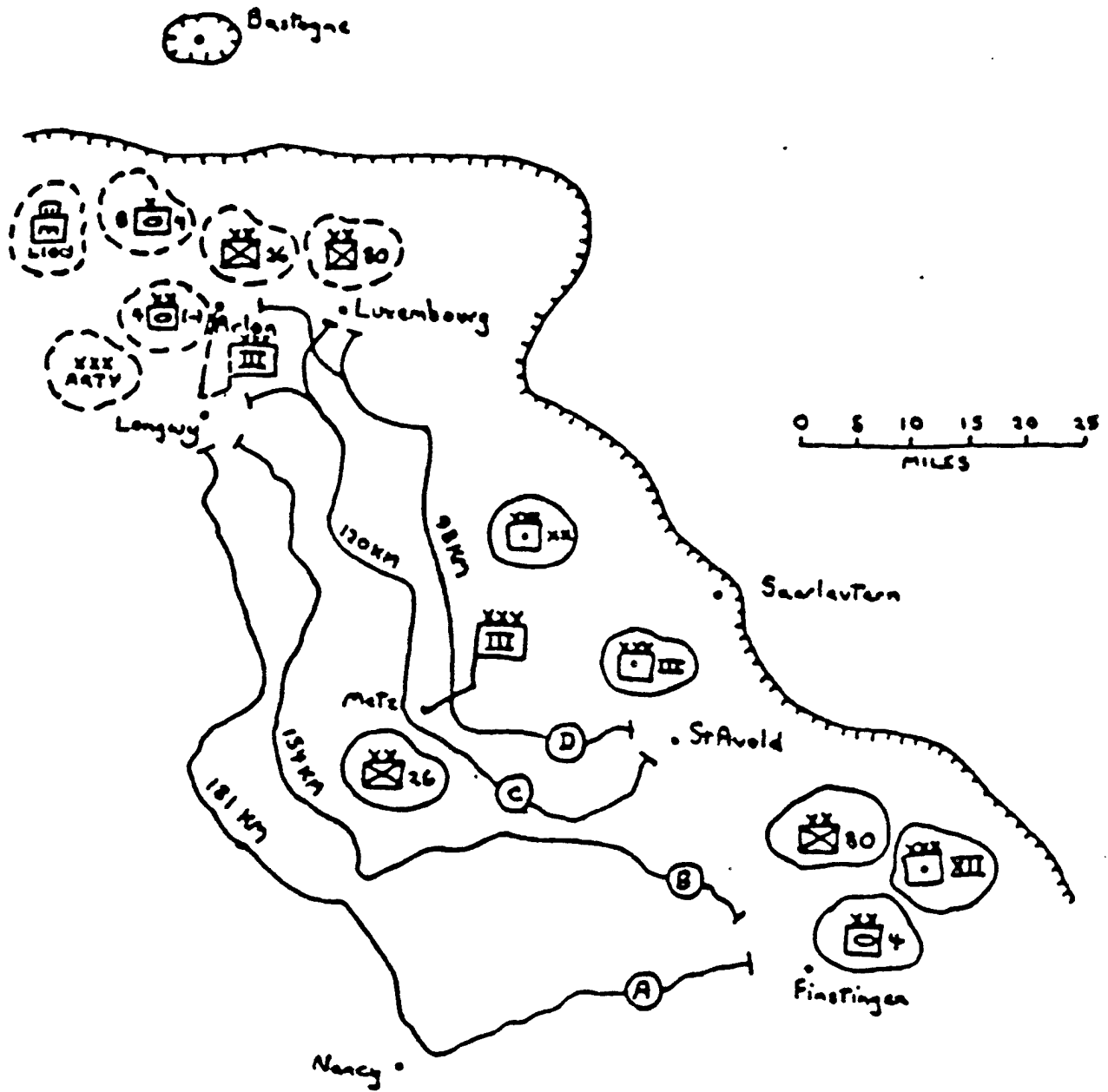


MAP 2: CCB, 1st Armored Division Movement, 18-28 November 1942.

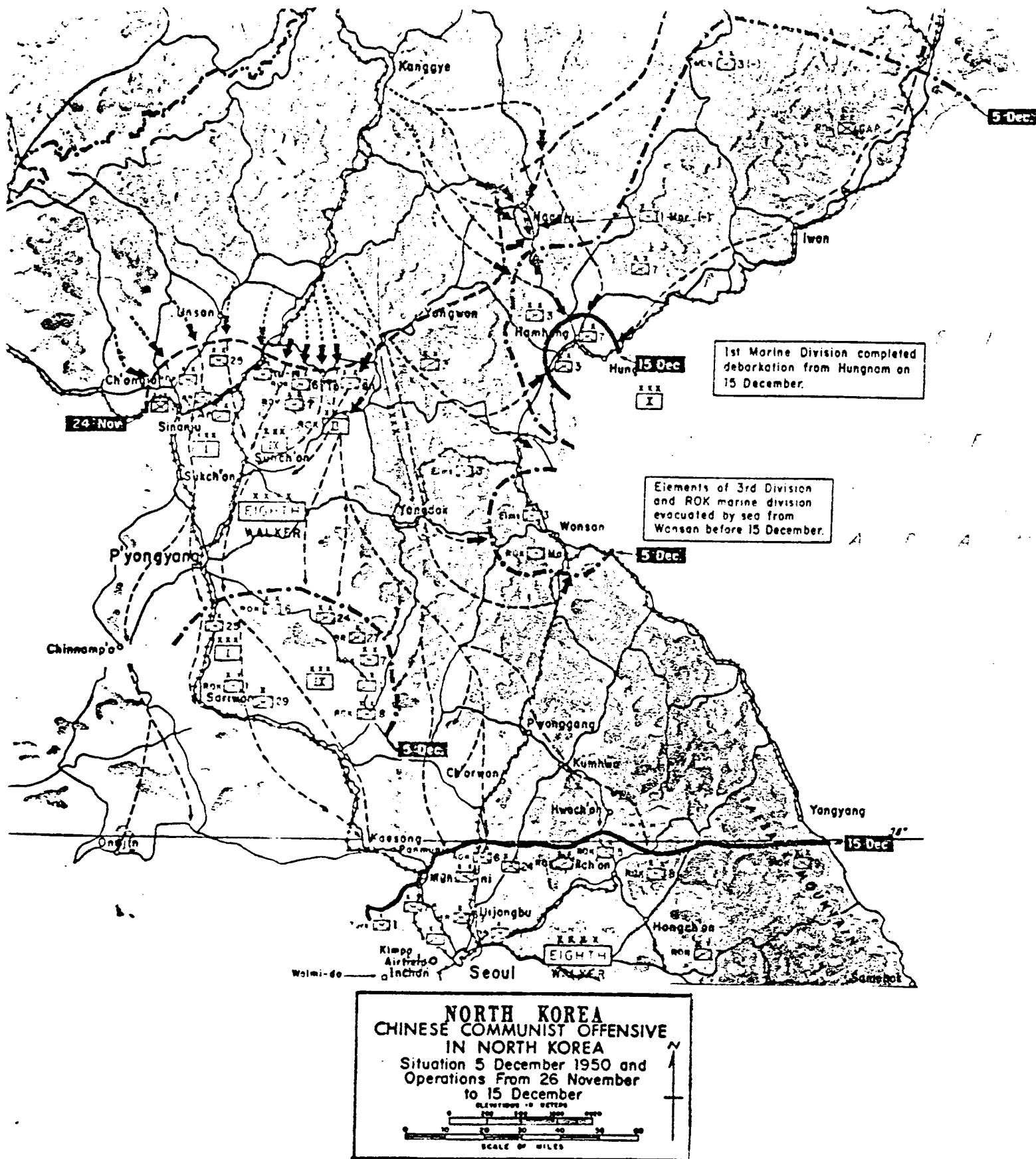
Note: Each arrow represents one division.



MAP 3: The II Corps Operational Movement, 10-25 April 1943.



MAP 4: The III Corps Operational Movement, 18-21 December 1944.

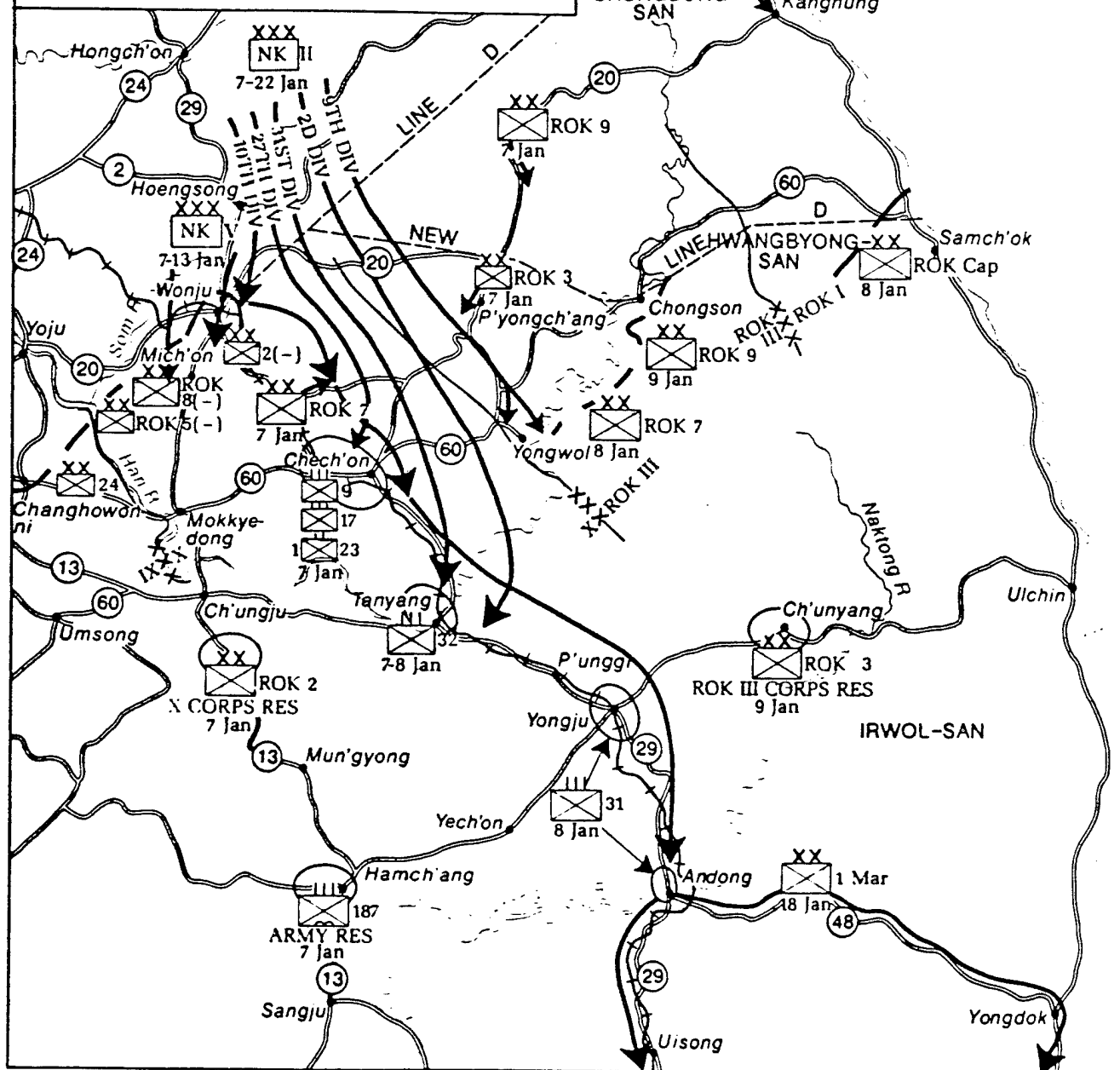


MAP 5: The X Corps Evacuation Northeastern Korea, December 1950.

NK II CORPS AND V CORPS ATTACKS

7-22 January 1951

- X Corps Frontline, Morning, 7 Jan
 - Other U.S. and ROK Positions Occupied or Established on Dates Indicated
 - Axis of N.K. Attacks, Dates Indicated
 - High Ground Above 1000 Feet
- 0 25 MILES

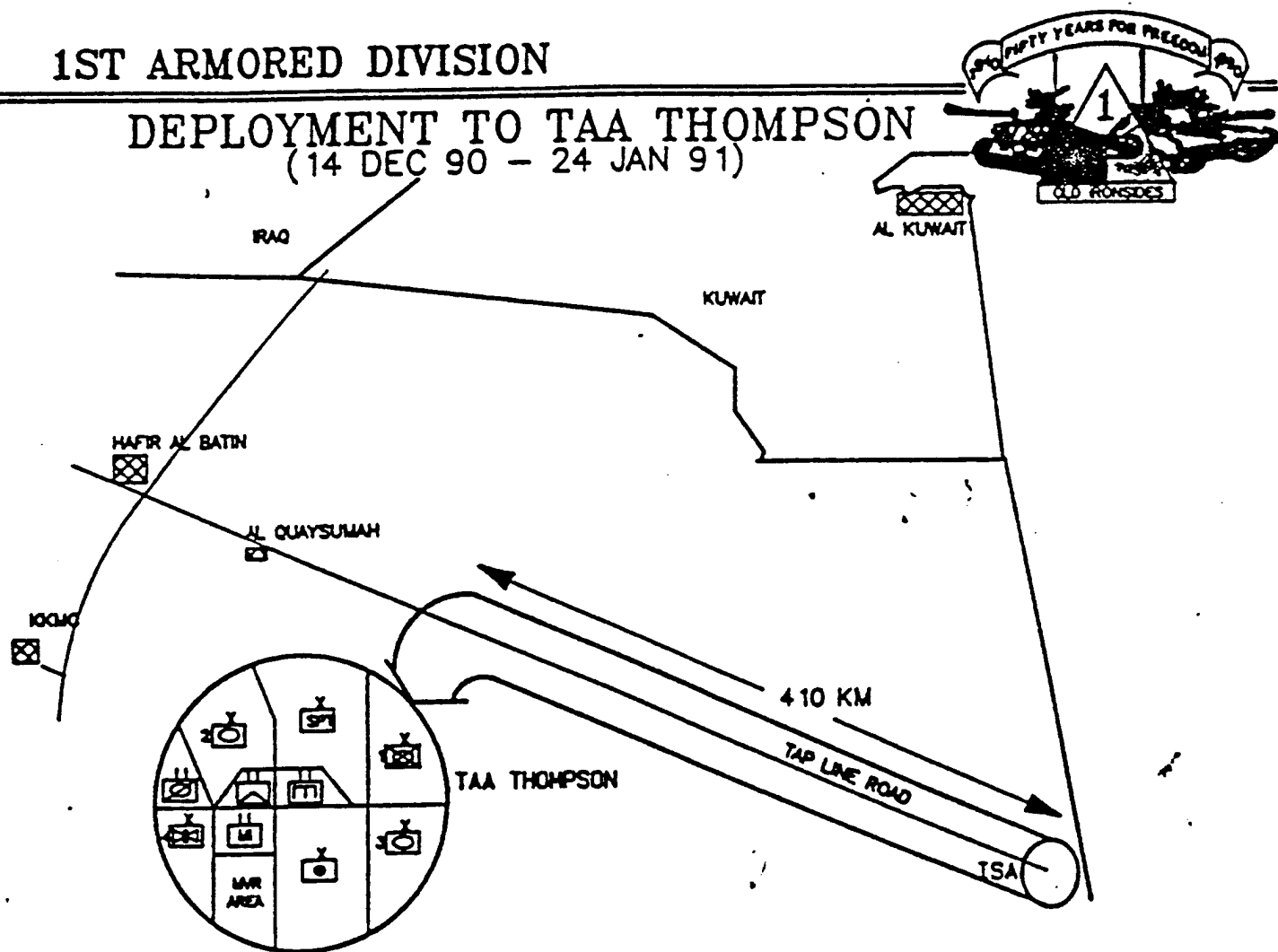


MAP 6: The X Corps Defense of Line D, 7-22 January 1951.

1ST ARMORED DIVISION

DEPLOYMENT TO TAA THOMPSON

(14 DEC 90 - 24 JAN 91)

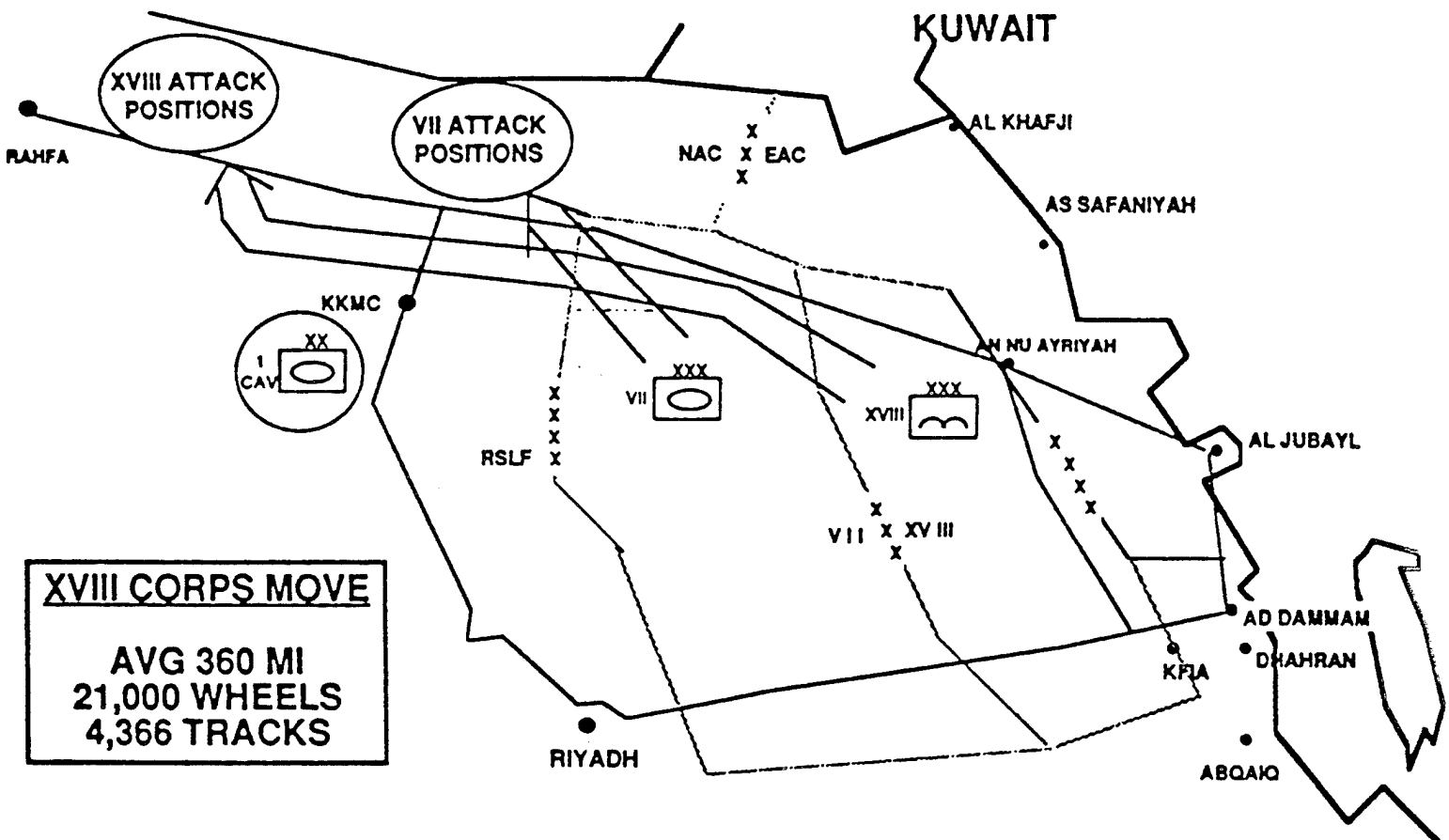


MAP 7: The 1st Armored Division Movement from the ISA to the TAA, 14 December 1990-24 January 1991.



"ALWAYS FIRST -
WE WERE"

MOVEMENT OF TWO CORPS



MAP 8: Third Army's Operational Movement, 8-22 February 1991.

ROAD MARCHES		L CORPS MARCH COLUMN ON ROUTE BLACK	
$\text{EXTAL} = \frac{\text{no. of vehicles}}{25}$		$\text{TDIS} = \frac{\text{distance}}{\text{rate of march}}$	$\text{no. of gaps} = \text{no. of elements} - 1$
$\text{PST} = \left[\frac{(\text{no. of vehicles} \times 60)}{(\text{density} \times \text{speed})} \right] + \text{EXTAL} + (\text{no. of times gaps} \times \text{min/time gap})$			
$\text{Density} = \frac{1,000\text{m/Vehicle distance(m)}}{\text{Length of vehicle (m)}}$			
March Unit			
No. of Vehicles in MU	25	Then no. of vehicle gaps is	24
Route Distance (km)	378	Then EXTAL is	1
Speed (kmh)	27.5	Then length of MU is	775
Rate of March from table (kmh)	27.5	Then Density is	31.25
Vehicle Distance (m)	25	Then MU Pass Time is	2.745455
Length of Vehicle (m)	7	Then TDIS is	13.74545

APPENDIX A: The L Corps Road March Parameters.

[illegible]

MOVEMENT PLANNING

61

MOVEMENT PLANNING																			
PARAMETERS:		(KMPH)	(METERS)	(NO.)	(NO.)	(MINUTES)	(METERS)	(MINUTES)	(METERS)	(MINUTES)	(METERS)	(MINUTES)	(METERS)	(MINUTES)	(METERS)	(MINUTES)	(METERS)	(MINUTES)	(METERS)
VPK	AVG RATE	VEH	VEH	VEH PER	MU PER	MU TIME	MU GAP	MU GAP	SER GAP	SER GAP	REST	REST	REST	REST	REST	REST	REST	REST	REST
17.5	27.5	50	50	25	8	2	916.667	5	2291.67	0	80	90	3446.67	0	80	90	3446.67	0	80
UNIT	# VEH	MU FACT	# MU	SER FACT	# SER	EXTAL	REST	HALTS	ROM	COLUMN	PST	MARCH	EXTAL	ROM	MARCH	EXTAL	ROM	MARCH	EXTAL
1-22 CAV	163	6.52	6	0.815	1	7.52	0	480	540	19399.7	42.8421	440	960	4050	120816	305.248	440	960	4050
3/23D BD	1131	45.24	45	5.655	6	46.24	0	3600	4050	120816	305.248	440	960	4050	120816	305.248	440	960	4050
23DIVART	138	5.52	5	0.69	1	6.52	0	400	450	17083	36.7252	440	960	450	17083	36.7252	440	960	450
61 FA BD	575	23	23	2.875	3	24	0	1840	2070	62638.3	154.688	440	960	2070	62638.3	154.688	440	960	2070
DV TRPS	648	25.92	26	3.24	4	26.92	0	2080	2340	71768	177.71	440	960	2340	71768	177.71	440	960	2340
	0	0	0	0	0	1	0	0	0	2480	-1	440	960	0	2480	-1	440	960	0
	0	0	0	0	0	1	0	0	0	2480	-1	440	960	0	2480	-1	440	960	0
	0	0	0	0	0	1	0	0	0	2480	-1	440	960	0	2480	-1	440	960	0
	0	0	0	0	0	1	0	0	0	2480	-1	440	960	0	2480	-1	440	960	0
	0	0	0	0	0	1	0	0	0	2480	-1	440	960	0	2480	-1	440	960	0
	0	0	0	0	0	1	0	0	0	2480	-1	440	960	0	2480	-1	440	960	0
TOTAL	2655		105		15	111.2	0	8400	9450	291705	717.213	440	960	9450	291705	717.213	440	960	9450
MOVEMENT TABLE		SP	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP10	RP	TOTAL						
UNIT	23D AD																		
ROUTE	GREEN																		
LOCATION		CHINHA	CHINYON	CHONGD	TAEGU	KIMCHON	YONGDO	POUN	KOESAN	CHANGH	N	YAJU	MUNMAK						
DISTANCE	NA		37	56	38	65	45	52	56	51	19	21	440 (KM)						
TIME	1.34545		1.34545	2.03636	1.38182	2.36364	1.63636	1.89091	2.03636	1.85455	0.69091	0.76364	16 (HOURS)						
H-HOUR	27.5		27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5						
AVG. SPEED	1.34545		1.34545	3.38182	5.09697	7.62727	9.4303	12.2403	14.4433	16.4645	18.0745	18.8381	27.5						
ARR	0		0	0	0	0	0	0	0	0	0	0	0						
REST MIN * # MU/60	0		0	35	17.5	17.5	17.5	17.5	17.5	17.5	0	0	0						
MAINT MIN * # MU/60	0		0	0	0	0	0	0	0	0	0	0	0						
ROM MIN * # MU/60	0		0	0	0	0	0	0	0	0	0	0	0						
CLR	13.2988		50.3352	34.5503	37.0806	117.884	41.6936	43.8966	124.918	30.0278	30.7914	30.7914	158 (HOURS)						
PST MIN	717.2		11.9533																
# MUNITS	105																		

MOVEMENT PLANNING

63

MOVEMENT PLANNING

64

COMPARATIVE PORT CAPACITY IN SOUTHEASTERN KOREA					
	SHORT TONS PER DAY				
MASAN		7989			
CHINHAE		2370			
PUSAN		146599			
ULSAN, MIPO, & ONSAN		29791			
POHANG		<u>82494</u>			
TOTAL		269243			

APPENDIX C: Comparative Port Capacity in Southeastern Korea.

COMPARATIVE MOVEMENT RATES											
		1ST ARM	TORCH, 1942-43		ARDENNES, 1944	LINE D, 1951	REFORGER, 1987	DESERT SHIELD			
		YES	CCB, 1AD	II CORPS	III CORPS	7TH ID	IIICORPS	1ST AD	VII CRP	XVIII CRP	
ENEMY CONTACT			YES	NO	YES	YES	NO	NO	NO	NO	
# SOLDIERS		30,000	3500	80,000	80,000	10,000	40,000	22,234	140,000	115,000	
# AIRCRAFT				52	42	10	254	124			
# TRACKED VEHICLES		638	442	1955	1713	242	3334	1819	6598	4366	
# WHEELED VEHICLES		1355	403	9724	7691	2106	7221	6231	32000	21000	
TOTAL # VEHICLES		1993	845	11731	9446	2358	10,809	8174	38,596	25,366	
SUPPLIES				1,100				966			
DISTANC (KILOMETERS)		1120	1120	432	181	344	150	410	226	580	
TIME (DAYS)		17	10	15	2.5	3	1.5	34	14	14	
RATE		2.8	4.7	1.1	3	4.8	4.2	0.5	0.7	1.7	
(KILOMETERS-IN-AN-HOUR)											
MODES USED		ALL	M,R,W	M,R	M,R	M,R	M,R	M	M	M,R,A	
MOVEMENT CONTROL		DECNTRL	DECNTRL	CENTRAL	CORPS	CORPS	JMCC	TMCC	TMCC	TMCC	
LOGISTICS PROBLEMS		PORT BACKLOG: LACK OF STEVEDORES & MHE; LOST TAV & ITV.	PORT BACKLOG: LACK OF STEVEDORES & MHE; LOST TAV & ITV.			PORT BACKLOG			PORT BACKLOG: LACK OF STEVEDORES, MHE, & HETS; LOST TAV & ITV.		

APPENDIX D: Comparative Movement Rates.

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